THE ENGINEERING MAGAZINE

VOL. XXIII. SEPTEMBER, 1902. No. 6.

THE NAVAL ENGINEER OF THE FUTURE.

By Walter M. McFarland.

THE succeeding article in this issue by Inspector Johnson, to which Mr. McFarland's serves as preface and commentary, deals with the British navy. Mr. Johnson's extremely pessimistic view of the outlook for naval engineering therein naturally suggested that a discussion of naval engineering in the United States navy would be opportune as a companion article, and Mr. McFarland was asked to prepare such an article, which would at the same time give the opinion of an American engineer on the views advanced by Mr. Johnson. In view of his long service as an engineer in the American navy, which he left only a few years since, and of his active connection with the Personnel Board, he seemed to the editors the most suitable person to undertake this task; and he does it as he says the more willingly because his interest in the navy, and particularly its engineering, is as great as ever, and if he can aid in disseminating right ideas as to what is necessary for the highest engineering efficiency, he will feel that it is a duty faithfully performed. Both articles, extremely important in themselves, are doubled in interest by this companionship in presentation.—THE EDITORS.

MR. JOHNSON'S views of the future of the British naval engineer are distinctly pessimistic, and are recognized by him as being so. Indeed, the British engineer can hardly be blamed for losing heart when he sees how apparently futile have been all the efforts to give engineering in the British navy its rightful standing. The most discouraging feature is the pretense to investigate the subject and to do justice. It would be less discouraging to have a brutally frank refusal, because it would be realized at once that this could be due only to utter ignorance of the subject, while the continual postponement is an indication that the justice of the demands is recognized but that there is an unwillingness to comply with them.

While sympathizing very heartily with Mr. Johnson in his disappointment at the turn affairs have taken, and, to some extent, with his feeling that, while the engineers are getting no greater authority, they

are being deprived of important duties, I feel that he is not looking far enough ahead and is making a decided mistake in considering the Admiralty regulation which puts certain duties formerly performed by the engineers under executive officers a great misfortune. As a matter of fact, in my judgment, this is simply the beginning of a movement which is bound to lead to the same results as have been reached in the American navy. Just here it may be well to comment on that part of Mr. Johnson's article, in his criticism of the Admiralty, where he excuses the First Lord on the ground that he is a civilian and entirely at the mercy of his naval colleagues. In my judgment this is an utterly mistaken view, and the First Lord is the one most to blame, for the very reason that, being a civilian, he ought not to have any personal prejudice in the matter and ought to be open to hear both sides of the case (although, in fact, there is really only one side in the judgment of all engineers), and thus be able to render substantial justice. The result of my observation for many years has been that this plea that a civilian head of a military or naval organization is not able to pass on technical matters, is simply a convenient excuse for not making decisions where it requires some strength of character to do so. A really strong civilian has no difficulty at all in getting at the facts of these technical matters, as was shown by the splendid grasp of naval matters possessed by President Roosevelt when he was Assistant Secretary of the Navy.

I have taken pains for many years to keep in close touch with the question of the position of engineers and their aspirations in both the American and the British navies, and, speaking broadly, these aspirations have been the same. Beginning as the representatives of a department which was small and of secondary importance, they have seen their work grow until in the minds of unprejudiced persons it has become the most important in the navy, meaning, of course, that the growth of the modern war-ship has been along such lines as to make it what it has been so often and so aptly designated, "a floating machine shop." With this growth in the importance of machinery there has been the accompanying growth in the number of men necessary to take care of it, thereby greatly increasing the executive side of the engineers' duties; and the necessity of having the legal right to exercise this executive authority has been the motive impelling engineers to demand full recognition for their position as military officers in a military organization.

This whole matter has been discussed thoroughly by many able men, and so recently that what they have written is readily accessible;

but it may be remarked that Secretary Gideon Welles, of the American navy, as far back as 1864 and 1865, recognized that the thoroughly competent naval officer should be an engineer as well as a sailor. Since that time various others have advanced similar views.

That the American navy was the first to give engineers their rightful position is due very largely to the good fortune that President Roosevelt was for a time Assistant Secretary of the Navy. With his tireless energy and constant aim to make everything with which he is connected highly efficient, it was necessary only that his attention should be called to the merits of the case to have him take it actively in hand. Before closing this aspect of the case, it may be well to say, as I had an opportunity of doing before the House naval committee, that engineers in other navies besides the British and American are dissatisfied with the lack of proper recognition of their position, the difference being that in these two countries they had a chance to make themselves heard, while in the others red tape and naval regulations prevent their saying anything publicly, and one knows of their feeling only from hearing about it in private conversation. It is a fact, however, that engineers of other countries are as dissatisfied with their treatment and have exactly the same aspirations as those of Britain and America, and when those of Britain shall have been as fortunate as those of America, the engineers of other countries may expect their turn to come.

In the discussions of the claims of the engineers in the American navy, a point which was frequently made by executive officers was that it would not be right to give engineers military titles because engineering was not military work. In the American navy it did not seem to be apprehended that if this were true the converse was equally true, namely, that it would be wrong for men with military titles to perform engineering duty. As a matter of fact, ordnance and electricity have always been in the hands of the executive in the American navy, so that so far as this feature of the recent Admiralty regulation is concerned, the British navy is now simply doing what the American navy had been doing for many years. Of course when such machinery was damaged so as to need special engineering skill, the engineers were called in to take charge of the work. It was this very fact, that the executive officers in the American navy were already doing engineering work, that made it easy, when Mr. Roosevelt took hold of the matter, to bring about the amalgamation. In other words, the executive was to take on more engineering and the engineer was to have more executive training, when the two would become the same.

It seems to me that Mr. Johnson has missed the point that the Admiralty regulation transferring certain strictly engineering work to executive officers is really an admission that military titles are not inconsistent with engineering duty, and that consequently this move should be looked upon as an admission, although a half-hearted one and very unsatisfactory one, that the claims of the engineers are just. In view of the outcome in the navy of the United States, which is well-known to all students of the subject, it seems to me that this recent Admiralty regulation should really be a source of some satisfaction to British engineers, but it should not cause them to relax their efforts to secure their proper standing. Of course it can be satisfactory in a negative way only, for they personally have not as yet gained anything; but the action of the Admiralty brings out forcibly the truth of President Roosevelt's remark in his report to the Secretary of the Navy, where he says:

> "Every officer on a modern war vessel in reality has to be an engineer whether he wants to or not. Everything on such a vessel goes by machinery, and every officer, whether dealing with the turrets or the engine room, has to do engineer's work. There is no longer any reason for having a separate body of engineers, responsible for only a part of the machinery. What we need is one homogeneous body, all of whose members are trained for the efficient performance of the duties of the modern line officer. The midshipman will be grounded in all these duties at Annapolis, and will be perfected likewise in all of them by actual work after graduation. We are not making a revolution; we are merely recognizing and giving shape to an evolution which has come slowly but surely and naturally, and we propose to reorganize the navy along the lines indicated by the course of the evolution itself."

It may be well in this connection to consider some of the objections which have been advanced against the idea so well expressed in the quotation from President Roosevelt. Mr. Johnson has put forward one, where he speaks of the long period given to the training of the men who at present do only engineering work, his idea being, evidently, that it would be practically impossible for men already trained for a different profession to acquire engineering in addition. There are also those who object to this idea of the one homogeneous body of officers, on the ground that this is an age of specialization and that such a course is contrary to the spirit of the age. The simple fact is that the logical basis for this idea of one homogeneous body whose members will be what Congressman Foss, chairman of the naval committee of the House of Representatives, calls "fighting engineers," is a thorough training in engineering. It is probable that the average

layman, not familiar with the curriculum of the United States Naval School at Annapolis, has little idea that even before the amalgamation it was essentially an engineering school; and yet line officers had exactly the same mathematical training, including applied mechanics, as the engineers, as well as the same courses in physics and chemistry, and they studied ordnance from an engineering side while the engineers took up strength of materials and steam engineering. The present superintendent of the Naval Academy, Captain Wainwright, who was a member of the Personnel Board, recently published an article in one of the leading American periodicals about the Naval Academy, in which occurs the following statement:—

> "At the close of the Civil War, the study of steam was introduced, but unfortunately, the advice of Isherwood was neglected and the students were separated, some remaining sailors with little training in engineering, while others became engineers with little training in executive duties. But the necessities of the service required the seamen to be trained in ordnance and electrical engineering with some knowledge of the steam engine, so that when the amalgamation came and the mistake made thirty odd years ago was rectified, there was no great change in training necessary. The seaman was taught a little more engineering and the engineer a little more seamanship, and now true marine engineering includes steam, electricity, and ordnance."

This shows that this accomplished officer, who occupies the extremely responsible position of training young naval officers, understands thoroughly what is to be done to carry out the idea of making the modern line officer a fighting engineer, and in the same article he makes another statement as follows:—

> "The course at the Naval Academy places in his hands the means to become an ideal seaman and marine engineer, lacking only experience at sea to make him a thorough American naval officer."

Everyone who has had experience on a modern war vessel realizes that skill as a seaman is not obtained by reading books, but by actual experience in handling vessels in all sorts of weather, and this can be acquired only at sea. Very much the same is true of the executive duties in the handling of men. This can come only from contact with them, and it is notorious that high scholastic attainments are not necessarily an idex of success in this work. It comes to this, that the preliminary work which can be given in the schools to the best advantage is the preliminary engineering training, with the principles of sailorizing and military duties, which are also learned by drills; but the final efficiency must come, as Captain Wainwright says, through experience at sea.

With regard to the matter of specialization, we must not be misled

by general terms nor forget that the war vessel is itself a very marked specialty. Each war vessel has to be complete in itself, and it would be absurd to attempt to provide a specialist of the highest type for each of the many things which may be necessary. The real fact is that the modern naval officer, the fighting engineer, will be a specialist in the most exact sense of the term. A certain set of conditions has to be fulfilled by him, and the midshipmen at the Naval School are being trained to fill these very conditions. It may, of course, occur to some, as it did to members of the Personnel Board when the matter was under discussion, that care must be taken to have competent designing and constructing engineers. In this matter we had the experience of the navy in ordnance to guide us, for without any separate corps of ordnance specialists in the navy, there had always been a sufficiently numerous body of officers who paid special attention to ordnance and furnished the necessary designers. With a body of more than a thousand officers to choose from, all of whom in time will have been trained as engineers, it would be absurd to think that the necessary men for designers and constructing engineers could not be obtained. Another matter which ought to be frankly recognized and admitted, is that none of the duties performed by naval officers, in whatever branch of engineering, are occult or such that only men of the highest genius can perform them. For designers men of remarkable talent are needed, but, as shown above, there will be no difficulty to get them. Every-day routine work requires men who have had suitable preliminary training and adequate experience, and with an honest effort to give the young officers the necessary experience it will be obtained.

In this connection the obvious inquiry will occur to every reader:—How has the Personnel Law in the American navy worked out in the three years that have elapsed since it was passed? The answer to this is that thus far the result is very disappointing, but the reason is very simple. For a long time not the slightest effort was made to carry out the essential idea of the amalgamation, namely, that of regular alternation between the deck and the engine room for all the young officers. When the scheme was mooted it was believed that Mr. Roosevelt would be in power to see that his ideas were carried out; but, as is well-known, he had left the Navy Department even before the bill was passed and, although always retaining his interest, had no opportunity until recently to bring any personal effort to bear on its enforcement. The friends of the measure did all they could to have it carried out, but its actual administration fell into the hands of an offi-

cer who, having been a member of the Personnel Board, was openly opposed to the principle from the very start and always stated that he was opposed to it. It is a fact that, owing to Congress not having made the provision which had been contemplated for additional officers, there were difficulties in the way of providing for the alternation of duty, and it would not be warrantable to say that this officer did not want the measure to be a success and therefore made no effort. Before vacating the position which put the administration of these matters in his hands, he had initiated an effort looking towards at least a partial carrying out of the idea, and this is now going on. Admiral Sampson, who had been a member of the Personnel Board, was Commander-in-Chief of the North Atlantic squadron when the bill passed; and as soon as he had received official notice of it he issued a squadron order showing that he thoroughly appreciated what was necessary. This order reads as follows:—

"April 12th, 1899.

"In view of the fact that hereafter the junior officers of the service will be called upon to perform the duties of both line and engineer officers, it is essential that they should be taught both of these duties.

You will therefore make such arrangements for this purpose as the number of officers under your immediate command will allow.

To all officers below the grade of junior lieutenant you will assign the duties of engineer officer, and to all assistant engineers, you will assign the duties of line officers as far as the number of officers serving on board the vessel under your command will permit.

This interchange of duties for the line and engineering officers will take place for the space of one month."

Admiral Sampson, with his usual clearness of vision, realized that efficiency in both parts of the duties of the modern officer could be secured only by continual performance of each of them. It will be noticed that the interchange of duties was to take place for a month, and this is a feature which the writer has always insisted upon from the first suggestion of the idea of amalgamation. To make one cruise as an engineer and another as a deck officer, would never give that thorough familiarity with both duties which is absolutely essential.

Although in the quotation from President Roosevelt's report given above, the statement is made, and correctly, that the amalgamation is not a revolution but an evolution, nevertheless, considering the intense conservatism of naval officers and the prejudices which are the growth of many decades, the change is of a very radical nature. This ought always to be borne in mind when considering the question of how rapidly the new state of affairs contemplated is being brought about. In

this age of so many marvels of high speed there is a danger that we may expect these economic changes to occur as rapidly as the transformation of a cable railway into an electric. I personally have spent many sad hours in thinking how slowly the change in the American navy is being made, when with hearty effort on the part of all concerned it might have been pushed with enthusiasm and we might already be congratulating ourselves on the splendid results attained. However, we must not give up in despair and talk about the doom of engineering, simply because what we believe to be the best method of securing the highest engineering efficiency does not receive complete acceptance on all sides at once. It was an enormous step in advance to have the fact recognized that engineering is the basis of the training of the naval officer, and to have this recognition set forth so strongly by a man who is now President of the United States and to have it enacted into law. Engineers had been working and waiting for more than fifty years hoping to accomplish much less than this. The ground has been cleared, the right principle is recognized, and an effort is being made to carry out the principle. Congress at its last session provided for a large increase in the number of cadets at the Naval Academy, and in a few years when they become available and there are officers enough to give the scheme a fair trial, there can be little doubt that it will be tried in earnest.

As has already been stated, the idea of amalgamation in what might be called a practical form, or, as may be otherwise expressed, its presentation at the opportune moment, was due to Admiral Evans; but he, of course, does not claim to be the originator of the idea. As I have stated above, Secretary Welles had this idea nearly forty years ago and, to my certain knowledge, many thoughtful American naval officers, both of the line and of the engineers, had realized that one homogeneous body of officers was the ultimate solution. While we may regret that progress toward the ideal is much slower than we would like, we must not, therefore, give up the ideal; and hence I believe that, although Inspector Johnson has good cause for feeling that the Admiralty have not given the British engineers proper treatment, he and his friends should not sit down in despair; but they and the friends of engineering all the world over should hope on, fight on, and use their influence to hasten the day when it will be generally acknowledged that the modern naval officer is in fact what so many earnest students of the case have asserted he must be—a fighting engineer.

THE DOOM OF THE NAVAL ENGINEER.

By Charles M. Johnson.

IN this, the second year of the twentieth century, it sounds somewhat pessimistic to head an article "The Doom of the Naval Engineer"; but the Admiralty order of 9 January last to the commander-in-chief at Portsmouth, directing that in future certain machinery is to pass from the charge and control of the engineer officer to that of the gunnery or torpedo lieutenants, respectively, seems to me fully to justify the title.

At a time when the engineer is supreme in every avenue of life—when the aid of machinery and of mechanical science is every day more widely sought to shorten distances, to accelerate motion, to abolish manual labour, and to transfer from the uncertainty of the human agent to the infallible mechanical process all that may be done by the ingenuity and the adaptations of the engineer's science—at such a time, to take a step which is evidently but the precursor of others having as their ultimate end and consummation, the abolition of the naval engineer—is surely to court the destruction of the navy and the utter extinction of British naval supremacy. If the Admiralty are right in thus presaging the abolition of the engineer, the whole commercial and manufacturing world must be acting on erroneous principles, and will shortly have to reconsider its policy with the view of reconciling it with the astute decision of the British naval board.

Every reading man knows that for many years the engineering department of the navy has been in a more than unsatisfactory condition; it has been in a state of partial collapse. It is not from one public paper alone that the trumpet sound of danger has come. Every correspondent who has been permitted to accompany the ships on the summer cruise or in the autumn manœuvres, has to a greater or less extent played on the same note. Some, like Mr. Rudyard Kipling, have not hesitated to "call a spade a spade." They have manfully and impartially endeavoured to bring home to the "man in the street" the deplorable weakness and inefficiency of this branch of the navy. Public men of all classes have joined in protest against this paralysing state of affairs in Great Britain's first and only line of de-

fence. The naval engineers themselves have—as far as the "Regulations" permit—represented to the Admiralty, through the proper channels, the absolute necessity of redressing, not their personal or collective grievances, but the grievances of the British taxpayer, inflicted on him through the utter neglect and starvation of the engineering department. The great engineering institutions throughout the country have talked over the matter, have investigated it as a question worthy of their deepest interest and study. Prominent men in the profession, like Mr. D. B. Morison of Hartlepool and others, have given prodigally of their valuable time to study and master the subject to its minutest detail. Members of Parliament, of every shade of party and of every grade of life, have spoken of it in the House and on political platforms. Together with an influential deputation of prominent engineers and ship-builders, about twenty members of the House of Commons, on the 16th July last, waited upon the First Lord of the Admiralty and laid their views before him. Last, but not least, officers of the military (commonly called the executive) branch of the navy have added their testimony to the imperative need which exists of placing the engineering department on a sounder and more satisfactory basis.

And what has been the result, as far as the Admiralty is concerned, of all of this great consensus of thought and opinion? Has it succeeded in removing one single disability from, or of adding even one per cent. of either officers or men to, this dangerously undermanned branch of the service? Has it strengthened the hands of the chief engineer by giving him a staff of better trained units, although no added numbers? Has it in any way met the need of the engineer for greater authority and more control over his staff? In fine, has the board done anything to meet this widespread and public demand for reformation in the engineering department of the navy?

If these questions were put to the Lords of the Admiralty, they would doubtless be answered in the affirmative; but as a member of this over-worked, under-manned, slighted, barely tolerated class, I not only answer it in the negative, but I must go further and charge the Admiralty* with deliberately sacrificing the national interests and

* In speaking of the Admiralty, one is compelled, in justice to the First Lord, to state distinctly that he cannot be held responsible for the shortcomings of the Board on such an exceptionally technical subject as this. It must be obvious to every thinker that on such questions, the First Lord must be entirely at the mercy of his naval colleagues; and that is why I think the board of Admiralty should consist chiefly of civilians, assisted by representatives of the executive, the engineering, and other branches of the service. There would then be some hope that justice would be meted out to all alike; impartially. But so long as the whole control and administration is absorbed by one branch only of the navy, so long may we expect to find privileges, rank, honours, emoluments, place, and power confined to that branch alone.

the Empire's safety to the professional interests and prejudices of their own class—the sailor element. To make good this charge, I here reproduce an order recently issued to the commander-in-chief at Portsmouth.

Admiralty. S. W.
9 Jan. 1902.

SIR:

I am commanded by the Lords Commissioners of the Admiralty to acquaint you that they have had under consideration the division of responsibility for the care and maintenance generally of gun mountings and torpedo appliances in His Majesty's ships, and are pleased to direct that in future the duties of the gunnery, torpedo, and engineer officers in connection therewith are to be as follows:

Gunnery Lieutenants:—To have charge of, and to be responsible for, the care and maintenance of all gun mountings, as well as for the hydraulic fittings in connection with the guns and hydraulically worked machines, outside the pumping engines at present used for serving them.

Torpedo Lieutenants:—To have charge of, and to be responsible for, the care and maintenance of all dynamos, electric motors, electric lighting, Whitehead torpedoes and discharges.

Engineer Officers:—To be in charge of all steam-driven machinery, and for the supply of water, electricity, or air, at the required pressure; and where dynamos are coupled to steam engines, they are to be responsible for running them, and supplying electricity at the proper voltage at the machine terminals.

2. My Lords desire that you will direct the captains of the Excellent and Vernon, and the chief inspector of machinery at Portsmouth, to consider and report upon the methods best calculated to facilitate the adoption of the change in systems, including the revision of the courses of instruction for both officers of the military and engineer branches, and the general regulations necessary to provide for the efficient performance of the duties which will in future appertain to the former, instead of the engineer officers, thereby freeing the latter for work from which they can ill be spared.

As it is desirable that this arrangement may take place as soon as possible, I am to add that proposals should be submitted for the establishment of a course of practical mechanical training for the officers of the military branch concerned, by means of which, and by the introduction of a staff of hydraulic and electrical artificers to work directly under their orders, the change in responsibility may be effected.

I am etc., etc.,
Signed, EVAN MACGREGOR.

To the Commander-in-Chief.
Portsmouth.

It will be seen that this order takes away certain machinery and certain scientific weapons from the engineer and places them in the hands of officers who are not only not engineers, but who have had no practical mechanical education, and the reason assigned is one of ex-

pediency, not of efficiency. This policy of sacrificing efficiency to expediency has been the policy of the Admiralty board for the past forty years—how much farther back it goes it is unnecessary now to enquire. It is more to the purpose to enquire into the reason for the proposed change in the care and management of certain machinery and weapons, and the probable results of that change should it take place.

We will take the Admiralty reason first:—"Thereby freeing the latter (the engineers) for work from which they can ill be spared. The Jesuitical casuistry of this statement it would be difficult to surpass. Ground down to absolute, unadulterated truth, it means that the chief-engineer's staff is insufficient for the work it has to do; but the Admiralty dare not say so, in face of their long-continued assertions to the contrary. The chief engineer is not a working mechanic—he is the head of the most important and comprehensive department on board ship, and therefore it is not to "free" him that this change is to be made. Neither is the senior engineer supposed to be a working mechanic, although—God help him!—he is too often obliged to put his shoulder to the wheel because the staff under him is not numerous enough for all there is to do. Neither is it to free the other engineer officers, because their duties are performed under the supervision of the chief engineer, and if there were only more of them the duties of the chief would be less exacting, and he would be able to carry on the work throughout his department with greater profit to the service, with greater satisfaction to himself, and to all those placed in authority over him, and would also be enabled to maintain a higher standard of efficiency everywhere. The reason given, then, can only be considered a subterfuge. It is put forward to mask and hide the real reason.

Let us then endeavour to ascertain what the real reason is, and for this purpose let us analyse the constitution of the present Board of Admiralty, and the staff of executive officers employed there. The First Lord of the Admiralty, Lord Selborne, is a peer and a civilian, and is therefore a negligible quantity in the consideration of this question. He stands, or should stand, an impartial, inflexibly just unit of the board, holding the scales without bias, and weighing all questions with a single eye to the efficiency of the navy, and the safety of the Empire. We may all desire to believe that as far as his surroundings will permit, this is Lord Selborne's attitude. Let us next, then, look at his colleagues. There are four Sea Lords to complete the Board of Admiralty, and the following table shows to which section of the executive or military branch of the navy each belongs, or did belong:—

First Sea Lord, Gunnery.
Second Sea Lord, Gunnery.
Third Sea Lord and Controller, Torpedo.
Fourth Sea Lord, Torpedo.*

So we see that all Lord Selborne's naval colleagues belong to either one or other of the sections of executive officers, to whom, by the new order, is to be committed the care and maintenance of the machinery and weapons taken away from the engineer, who from their first introduction into the service has had them in charge. The reason of the new order, therefore, is at once apparent to any naval man. It has for years been the ambition of the officers of the gunnery and torpedo sections to get rid of the expert supervision of the engineer as far as guns and torpedoes and their accessories were concerned, and to confine the chief engineer to the four walls—if I may so term them,—of the engine-room.† For years, the engineer has had to hold his office simply at the bias of the captain of the ship. Where that bias fell to the gunnery or torpedo side of the fence, everything which could be filched from him, without a too flagrant disregard of the regulations, was filched. And, of course, where the captain, like a sensible man, preferred that his ship should be run by experts rather than amateurs, the chief was left in undisputed possession of those machines and weapons which he is certainly the proper man to have the care and management of. In some cases where the engineer was ousted the results were disastrous; but what other result could be expected? On shore we do not, as a rule, as business men, put delicate and expensive machinery into the hands of amateur engineers (and that is just what our gunnery and torpedo lieutenants are) but we endeavour to get hold of good practical engineers, who combine theoretical knowledge with practice and experience. We then have some grounds for believing that our machines will be well looked after, that they will be run with judgment and discretion, and that we may expect to get full or nearly full value out of them. Our anxiety, under such circumstances, is reduced to a minimum. And what we as business men on shore would do, may be taken as a very safe guide for the administrators of a great spending department like the Admiralty. The country

* I have enumerated here only the officers actually occupying seats on the board; besides these there are many others employed at the Admiralty, belonging to these sections of the executive branch of the navy, whose active influence would be a great force in strengthening the hands of the board in such a matter.

† As far back as the year 1877 these officers intimated to the Admiralty their readiness to take charge of all machinery outside of the engine-room. They were "just a little too previous" at that time, but now that they fill all the leading positions at the Admiralty, what more reasonable than that they should seek to give effect to their little note of that early year?

wants no experiments of so reckless a character as the one here foreshadowed, played with its first line of defence. The risks are too momentous; the stakes are too large. There is no good reason why this change should be made, but there are many why it should not be made.

I have thus endeavoured to show that this new departure is presumably initiated in the interests of the gunners and torpedoists. But while looking after the interests of these sections to which they belong, the Lords of the Admiralty have also had an eye to the inexorable demand which has surrounded the Admiralty as with an atmosphere for so many years and which they have hitherto been able to ignore, or at least to pass by on the other side, but which they now intuitively perceive they will be unable to disregard much longer—the demand that the engineer staff in all ships shall be increased to adequate proportions, and that the engineer shall be given definite rank and authority. The Admiralty have for years set their faces resolutely against increasing the engineer staff. Why? Because if they permitted the engineer department to grow to its legitimate proportions—proportions corresponding to the multifarious duties which naturally and properly belong to it—it would quickly equal in numbers, if it did not surpass, the sailor element. When we remember that in the present day everything is done as far as may be by mechanical means—that is, by the engineer, and that all the sailor is left to do is to fight the guns and keep the ship clean—are we not naturally surprised to find that the ratio between the sailor and the engineer branches respectively is as 4 to 1? Again I ask, why? Because command of men means power, and needs authority to wield that power. The engineer has no executive or military authority—he is a civilian! He can do nothing to reward or punish any member of his staff. It is by the mere accident of being what he is that he is able to have any control over the officers and men of his department. Not many years ago we had this strange anomaly, existing in the navy, that the engineer and his assistants belonged to the civil branch (as they still do), but their men belonged to the military branch. The appeal to this anomalous condition of affairs by those who even then advocated executive rank for the engineer was so frequent, and as numbers increased, so flagrant, that the Admiralty were forced to make most extensive changes in the military and civil branches, so that officers and men—who for years untold had been on the military list—found themselves, apparently without reason, suddenly relegated to the "shades and cold abstraction" of the civil list. Among these were the engine-room artificers and the stokers. And thus the Admiralty saved their face, and rid themselves of the

bugbear of being continually asked how they reconciled the anomaly of having executive men under the orders and control of civilian officers. Not that these men were thenceforth to carry shovels only, and no arms. Oh, no! The Admiralty did not intend to lose the services of these fine fellows who numbered among their ranks some of the best shots in the service; they deprived them of the name, but kept them as combatants all the same. Let South Africa and China bear witness to their value, both as combatants and handy men. Again I ask, why? Because the Admiralty would not give the engineer officers military command even in their own department. It was a case of doing either the one or the other, and the Admiralty chose the other. As shedding some light upon the spirit in which this demand is met by the Lords Commissioners of the Admiralty, it may not be out of place here to quote some sentences from the speech of Mr. Arnold-Forster in a discussion on the navy estimates on 26 February last. Mr. Arnold-Forster, like his chief, Lord Selborne, can speak of these matters only as he is instructed by his naval colleagues; therefore in reading his words we imbibe the spirit of the Lords Commissioners. With regard to this question of giving executive rank to the engineer officers, Mr. Arnold-Forster said:—

> "With regard to the question of punishment, what was claimed for the engineer officers *was something which was conceded to no other officer on board ship. The lieutenant* with the same seniority as the engineer *had absolutely no power of punishment.* There was, however, a difference of opinion among naval officers as to whether the claim should be conceded; but *it was necessary to go forward, if at all, very carefully,* because it was very easy to make mistakes. . . . . *The Naval Lords were very jealous of the privileges and rights of all branches of the navy,* and though they were ready to be impressed by every reasonable appeal for change, they would not accept such appeals without due consideration."

The italics are mine, and I wish here to pause awhile to notice one or two points I have thus emphasised. The first point I will deal with is the statement, that what was claimed for the engineer officers "was something which was conceded to no other officer on board ship." I am at a loss to understand how Mr. Arnold-Forster could have come to make such a grave mis-statement. He must for the moment, at any rate, have forgotten the marine officer, who has the very concession which it is sought to obtain for the engineer officer. The next point which I will deal with is:—"The lieutenant with the same seniority as the engineer had absolutely no power of punishment." This statement is even less understandable than the former. Is Mr. Arnold-Forster unaware, after nearly two years' experience at the Ad-

miralty, that in ships under the command of either a captain or a commander in which the next executive officer is called the "first lieutenant," all minor punishments are awarded by the first lieutenant? And that in vessels on detached service, having a lieutenant-commander in command, all punishments are awarded by him, when not actually in the presence of a senior officer? Few people will be disposed to quarrel with Mr. Arnold-Forster's dictum that "it was necessary to go forward, if at all, very carefully." The sting is in the parenthesis, "if at all." It seems to us that the Admiralty have no intention of going forward in this case; for they have had the recommendation of their own committee of 1875 under their consideration for twenty-seven years, and Mr. Arnold-Forster's words quoted above are their answer to that appeal when re-presented twenty-seven years after. One must confess that Mr. Arnold-Forster holds out the possibility that all is not lost, although in the year of grace one thousand nine hundred and two, he still thinks it advisable that the Admiralty should go slow on this momentous question. I come now to my last quotation from Mr. Arnold-Forster's speech, in which he states "the Naval Lords were very jealous of the privileges and rights of all branches of the navy." I am quite prepared to endorse Mr. Arnold-Forster's statement as far as the privileges and rights of the sailor branch of the navy are concerned, but doubts will assail me when I look back and think how one privilege after another has been taken away from the engineer. As an illustration let me cite one of the latest proofs of the "jealousy of the Naval Lords" for the privileges of the engineer. They were asked to put the fleet engineer on an equality as regards pay with other officers of the civil branch, whose duties are far less onerous, irksome, and dangerous; and what did the "jealousy" of the Naval Lords for the engineer's privileges achieve? They not only did not give what was asked for, but they actually took away, approximately, one-half of an old-established privilege—"charge pay"—which in many cases more than counterbalanced the small increase of pay which they gave. That is an instance of the Admiralty's "jealousy" for our privileges, of which I make Mr. Arnold-Forster a present, so that he may be able to produce it on the next occasion on which he desires to illustrate this peculiar virtue of the Admiralty, of which he is the sole discoverer.

How can one hope that justice will be done to the engineer when we find the mouthpiece of the Admiralty speaking such grave inaccuracies as these in the House of Commons? Had that august assembly numbered among its members but one naval engineer, Mr. Arnold-

Forster might have wished that his case had been a little more carefully got up.

It may be of interest to the readers of this magazine to note the names of a few of the members of late Admiralty boards, who, when out of office, advocated this bestowal of executive rank upon the engineer, but who on entering office, found it necessary and advisable, to go slow on the matter. The late Admiral Sir Astley Cooper Key was president of the committee of 1875, which recommended it; yet that officer was first Sea Lord for five years, but did not think it incumbent on him, as a man of principle, to give effect to the recommendation which he had himself presented to the Admiralty. Mr. (now Viscount) Goschen, when in opposition in 1877, was very sarcastic with the then First Lord, the late Mr. Ward Hunt, because it did not find a place in the naval programme for that year; yet he himself occupied the post of First Lord of the Admiralty for more than four years without finding means to introduce this reform which he thought so desirable in 1877. The late Mr. Otto Trevelyan is another instance of a man holding opinions when out of office, to which, in office, he fails to give effect.* And so I might go on adding to the list, but I think I have written enough to show that there is a very determined opposition on the part of the executive officers of the navy to sanction anything which shall confer on the engineer a rank and an authority "commensurate with the greatness of their present trust, and to the weight of their enlarged responsibilities;†" and that the parliamentary officials of the Admiralty, however favourable they may be, or may have been before attaining to office, to the conferment of executive rank upon the engineer, have always contrived to evade the question when in office, or else have been influenced by the naval atmosphere surrounding them to discover good and sufficient reasons why the engineer should remain a member of the civil branch of the navy.

Before proceeding to consider the remaining portions of this paper, viz., the probable results of the new order and the system of training necessary for the gunnery and torpedo lieutenants to enable them to carry out their new duties efficiently, let me sum up briefly the causes which have led the Admiralty to issue the new order.

I. The preponderance of gunnery and torpedo officers at the Admiralty.

* I am not aware that Mr. Arnold-Forster ever committed himself to an advocacy of this reform, but in the years anterior to his elevation to office he expressed himself as being in active sympathy with those engineer officers with whom he was brought in contact. He, also, has apparently succumbed to the baleful atmosphere of office.

† *Vide* Sir E. J. Reed's "Letters to the *Times*," 1877.

II. The growing necessity of reinforcing the engineer staff, in all ships; or as an alternative, of relieving the engineer of some portion of his multifarious duties and responsibilities.

III. The reluctance of the sailor element at the Admiralty to increase the engineer staff, because in doing so the importance of the engineer would also be increased.

IV. The insuperable objections entertained by the great majority of the executive officers to investing the engineer with executive rank and authority.

I pass now to the results which the proposed change is likely to have upon the standard of efficiency of the machinery and weapons included in the new order, and I think it unnecessary to do more than ask one single question, in answering which my readers will solve for themselves the point at issue:—"Is machinery of any sort, likely to be as efficiently handled, to give as good results, or to last as long, in the hands of amateurs as in those of experts?"

The third and last point in this question, viz., the training necessary for the executive officers who are to supplant the engineer officers may I think be dealt with as briefly as the second was. If they are to undertake the duties and responsibilities of the engineer, they must have an engineer's training to fit them for the work. Now what comprises the training of a naval engineer, before he is considered competent to undertake the independent charge of machinery? First, he serves five or six years in the workshops at Keyham, acquiring a practical acquaintance with the various branches of the mechanical side of an engineer's profession, a facility in the use and handling of all machines and tools comprised in a well-ordered engineering establishment, and a thorough knowledge of, and acquaintance with, the varieties of engines, machines, and mechanical appliances in use in the British navy. Having completed this pupilage, the student evolves into the assistant engineer, and is sent to sea under the orders of a superior engineer. He remains generally in this subordinate position for a further period of about ten years, when he is considered eligible for an appointment in charge of the machinery of a gun- or torpedo-boat. Is this the kind of training contemplated in the new order? I think not; because if it were the new order of things could not come into workable existence for many years, and the order states "that it is desirable that this arrangement may take place as soon as possible." No; the fact is the Admiralty entertains a sort of idea that the officers of the executive branch have a special "call" for the duties and work of any other branch. It remains to be seen whether the taxpayer will be equally impressed with their claim to oust the engineer.

Omineca Mountains from Peace River.

MINING INDUSTRY AND MINERAL RESOURCES OF BRITISH COLUMBIA.

By Wm. M. Brewer.

There are strong signs that the Pacific region of North America will exhibit within the next few decades one of the most wonderful industrial expansions the world has ever seen. The energy is there; the markets are but newly opened in the Far East; the machinery of commerce and traffic is being liberally supplied; that the fourth element—rich natural resources—exists in full proportion is indicated by Mr. Brewer's article, supplementing the important papers in this Magazine by Mr. Lamb, July and December, 1900, and Mr. Bogle, March, 1901. —The Editors.

THE Province of British Columbia is an enormous territory of varied resources, including mineral, timber, fish, agriculture and stock raising. It is hardly surprising, considering its extent (which is, roughly speaking, 1,500 miles north and south by 500 miles east and west) that large areas within its boundaries are *terra incognita* so far as the white man is concerned. Its island possessions are very numerous and embrace all of the islands in the Pacific north from San Juan Island, latitude 48° 20′ north, near the southern extremity of Vancouver Island, to Mary Island, latitude 55° north, near the entrance to Portland Canal, up which the provisional boundary line between British Columbia and the United States is located. A glance at the map of the province hardly enables one to form a clear conception of its extent, and especially does this statement apply to the length of coast lines. Extensive travel alone will impress on the mind the vastness and magnitude of this mountainous domain.

Nature has not only been very beneficent in scattering with lavish hand her resources, but has also been most generous in providing highways by which the explorer can travel during his work of research. The coast lines along the mainland and around the outlying islands are indented with sounds, bays, inlets, and canals, very similar

PORT ESSINGTON, AT THE MOUTH OF THE SKEENA RIVER.

to the fiords along the coast of Norway, while in the interior are many navigable rivers as well as lakes. The prospector is obliged in very many sections, and especially on the islands, to pack his blankets and supplies on his back; indeed, he considers himself particularly fortunate if he finds stage roads or pack trails over which he can use pack animals and saddle horses. The row-boat, canoe, and sloop are universally used along the coast lines and on the lakes, even though steamers ply on the waters, because it is of course impossible for the steam-boat companies to afford a service by which a prospector can thoroughly prosecute his work, and exploit the shore lines for indications of mineralisation. Glaciation and volcanic action are undoubtedly the responsible agencies for the formation of the fiords. Observation demonstrates that the general direction of the action of erosion from glaciation has been from northeast to southwest, the eastern shores of the islands being very much less cut up by bays and inlets than the western. The general trend of the mountain ranges is

to the northwest, as is also the direction of the coast lines. The islands are for the most part made up of one or more ranges of mountains, extending almost or altogether the entire length of each like a backbone, with series of deep cañons reaching from near the mountain summits to the shore lines like ribs. The mainland coast has a very similar appearance, for the Coast or Cascade Range of mountains extends along the entire coast line, from and south of the international boundary thence to the northwest through Alaska.

The mineralised zones follow the mountain ranges and to a certain extent parallel each other. Travelling from east to west there are first the Rocky Mountains, next the Selkirks, then the Gold Range, and last the Coast or Cascade range occupying the coast line and extending for about 100 miles inland.

The various mineral-bearing zones maintain throughout the province the some northwesterly lines of strike which characterise the mountain ranges, but the leads (if such a general term may be allowed) do not usually have their lines of strike conformably with those of the country rock. For instance, the coal seams in the Rockies through the Crow's Nest Pass territory strike to the north; many of the copper-gold ores in the Boundary district in southwestern British Columbia strike north also, but through the silver-lead district in the Slocan, many of the veins have a northeast and some an easterly strike. The same variation in lines of strike is also found on the coast and through the islands. The term lead, as applied to British Columbia ore bodies, is to a certain extent misleading, because some readers may interpret that term to mean continuous ledges of great length similar to the Colorado fissure veins, whereas so far as my observations have gone there are but very few ore bodies of this character in the province, and I have used the term in a general sense as being applicable to occurrences of ore of every character.

After a close study of the mineral resources of British Columbia extending over a period of four years, I have observed that the Gold range, which occupies a position between the Selkirk and Coast mountains, contains a mineralised zone remarkable for its length and production of placer gold. The southern portion is comparatively quite narrow, but the northern is very much wider. The free-milling gold-bearing quartz camps at Camp McKinney and Fairview, with the placer mining camp at Granite Creek, are located at the southern extremity of this zone, so far as it applies to British Columbia, while the northern portion is represented by the Atlin and Porcupine placer and free-milling gold-ore camps. The country lying between these points,

so far as it has been explored from south to north, embraces the old placer-mining camps on Granite Creek, Tulamene, Similkameen, and Fraser Rivers, as well as those in Cariboo, Omineca and Cassiar. North from Lytton, where the main line of the Canadian Pacific Railway crosses the Fraser River, the productive auriferous gravel extends over a much wider extent of country than either at the extreme south or extreme north in British Columbia. For instance, the Cariboo diggings extend towards the east in the Selkirk Range, and the Cariboo Range of mountains of that district belong to the northwestern portion of the Selkirk Range, as also do some of the mountains in the Omineca and Cassiar, while the mountains of the Atlin and Porcupine districts are northeastern continuations of the Coast Range. The same conditions as to increased width of this auriferous formation also applies on the western side, for it includes the free-milling ore zone through Revillagigedo and Douglas islands in southeastern Alaska.

But the extent of explored territory in British Columbia north from the main line of the Canadian Pacific Railway is very limited as compared with the unexplored portions. Practically, exploration has be-

gun and ended along the streams which really form the only highways through this enormous territory, and it is a remarkable fact that every important stream from Granite Creek north which flows through that portion of British Columbia lying between the Selkirk and Coast mountain ranges has contributed its quota of placer gold. Another fact, too, is worthy of record, which is that throughout that vast area but very few occurrences of free-milling auriferous quartz veins or deposits have yet been discovered. In the Lillooet district some have been worked on Cadwallader Creek, a tributary of Bridge River, as well as on McGilvray Creek, which flows into Anderson Lake, and on Cayoosh Creek, a tributary of the Fraser River. Those on this last-named creek, though, proved notable failures when the attempts to work them on a commercial scale were made. The reason for this was, that although the outcrops were rich and yielded quantities of fine specimens, yet deeper work resulted in exposing low-grade ore stringers only. The veins generally in that portion of the zone are of the

GOLD DREDGE ON THE FRASER RIVER AT YALE.

"gash" variety, lying conformably with the country rock as to dip and line of strike and pinching out into a series of narrow stringers of very low grade as depth is attained. But on Cadwallader and McGilvray Creeks the structure of the ore bodies is that of fissure veins which promise permanency with depth as well as along the line of strike, and besides it has been determined by milling operations that

the ore maintains a sufficiently high average grade to warrant mining operations whenever the camps are more easy of access than at the present time, when the cost for transporting machinery and supplies is from 5 cents to 7 cents per pound for packing from Lillooet to Cadwallader Creek, a distance of about 70 miles.

McGilvray Creek mines are more accessible because freight can be transported by water up Seton and Anderson Lakes to within a short distance from the camps. Inaccessibility and cost for freighting are the main causes for the unexplored condition of this vast territory designated as the Gold range, north from the Canadian Pacific Railway. Near the coast line the Coast range has been explored as far as could be easily done from the rivers and their tributaries. This work has resulted in the discovery of a mineralised zone containing magnetite, pyrrhotite, chalcopyrite, with occasionally bornite and some copper carbonates. In addition to these, occurrences of copper-gold ore bodies, usually at the contact between the igneous rocks and the limestones but sometimes filling fissures in the igneous rocks, have been discovered at several points. The most notable of these are on Seymour Creek, about ten miles northerly from Vancouver City, near the western shores of Howe Sound on Frederick Arm, on Bella Coola River, on the Skeena River, and on Observatory Inlet, as well

VIEW OF PINE CREEK, ATLIN, AT THE UPPER END OF THE FAIRVIEW LEASE, OPPOSITE THE STEPHEN DYKE GROUP.

CASCADE RANGE FROM SKEENA RIVER.

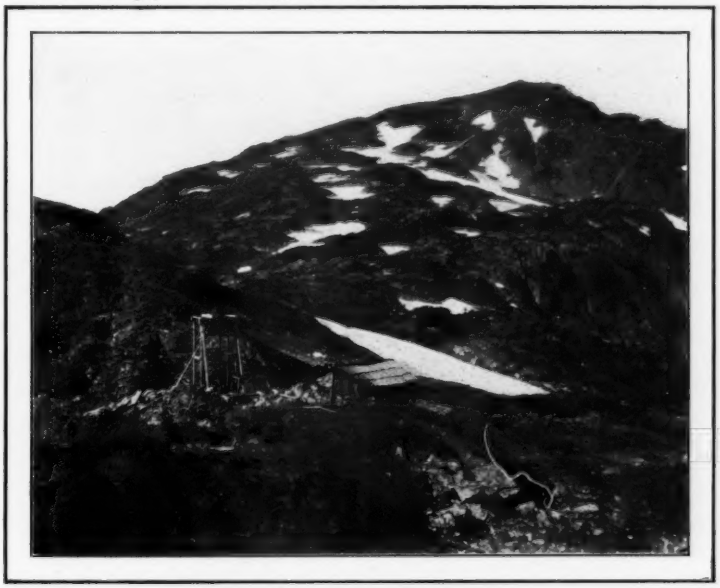
as on both the east and west sides of Prince of Wales Island. But the coast has been prospected only to a very limited extent, the main reasons being the unfavourable conditions prevailing as to thick timber, high mountains, impenetrable undergrowth, thickness of moss, lack of trails and necessity for packing supplies, etc., on men's backs. Consequently comparatively very little is known as to the mineral resources of the Coast range, and in fact the earliest discoveries of ore bodies, so far as British Columbia is concerned, date back only to about 1897. The outcroppings on the discoveries so far made have been generally unique, because of their vast extent. As an example of the most extensive outcroppings so far known there is that on the Britannia group of claims on Howe Sound, where occurs a mountain of ore about 6,000 feet long at the base, nearly 300 feet high, and in which a tunnel driven 125 feet long shows a solid mass of ore from the mouth to the face, with the face still in ore. This tunnel is not exactly a cross cut at right angles to the line of strike, but has been run slightly diagonal across the ore body. The altitude at the mouth of this tunnel near the base of the mountain is 4,250 feet above sea level, and only about three miles from the shore "as the crow flies."

CROSSING FRASER RIVER NEAR LILLOOET, B. C.

The same mineralised zone extends through the islands of the North Pacific. On Vancouver, Texada, Queen Charlotte, Princess Royal, and Banks, in British Columbia, as well as on Prince of Wales Island in Alaska, conditions exist very similar to those attaching to the mainland coast. There are, though, on Queen Charlotte and Vancouver Islands, in addition to the metalliferous bearing zones, extensive areas of cretaceous rocks containing seams of coal—bituminous on Vancouver Island, but anthracite on Queen Charlotte Islands.

Because of the discovery of coal on Vancouver Island about 1835

by Dr. Selwyn, who was then director of the Dominion Geological Survey, the Hudson's Bay Company about 1849 commenced the work of exploiting the coal measures, which resulted in opening collieries that have been producers on a commercial scale ever since, and for several years furnished the only local supply of coal on the Pacific Coast, having yielded 6,085,687 long tons to December 31st, 1901.



BORNITE MOUNTAIN, SKEENA RIVER.

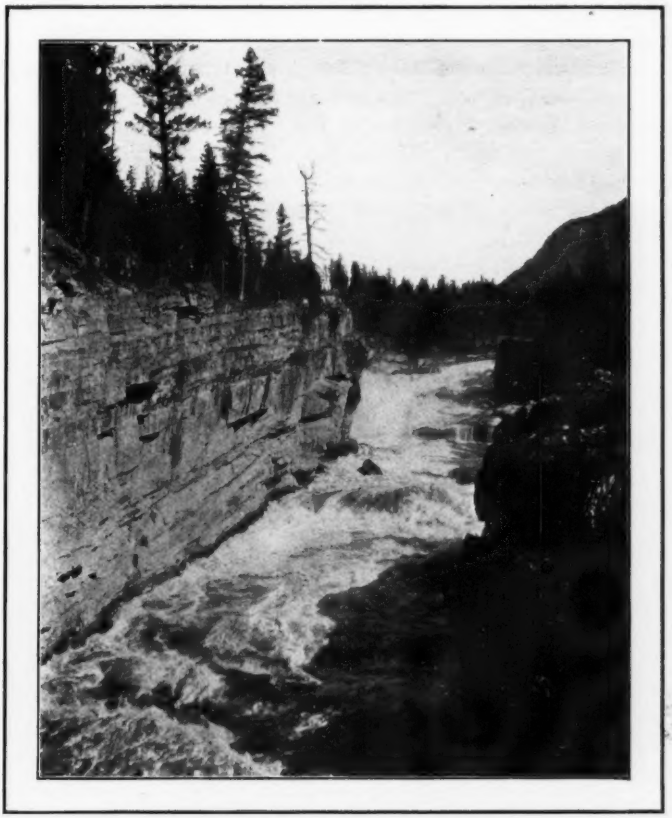
The coal measures on Queen Charlotte Islands have never been thoroughly explored; indeed, although large areas of land containing these coal measures were acquired under Crown grants several years ago, it has only been within the past two years that any attention whatever has been directed towards this group of islands by prospectors. Few parties have as yet visited it. In fact, except on Vancouver, Texada, and a few smaller islands, so little systematic exploring has been carried on that beyond the fact that a few discoveries of copper-gold bearing ores on Princess Royal and Banks Islands have been reported, the resources of the British Pacific Islands are unknown quantities. The Klondike excitement since 1897 has been responsible for the exploration and prospecting which have been carried on through the islands northward from Queen Charlotte Sound.

On Vancouver Island, placer gold was mined on Leach and Bear Rivers, and also on China and Granite Creeks, about 1862. These streams were worked out and for several years but little interest was taken in prospecting the mineral resources of the island, except the coal on the eastern side. In fact, 1897 is about the earliest date for the discovery of any of the deposits of the copper-gold ores which promise in the future to increase very materially the output of metals from the province.

Although the discoveries of the ores in the Rossland, Camp McKinney, and Boundary districts, south of the Canadian Pacific Railway on the mainland, antedate those on Vancouver Island, and have in the past been the main factors in bringing British Columbia into prominence as a mining centre, yet in this review I will confine detailed description of the mining industry to the island sections, beginning with Vancouver and proceeding eastward.

STEAMER HAZLETON ABOVE KITSILAS CAÑON, SKEENA RIVER.

On Vancouver Island prospecting for lodes was commenced about 1896 in the neighbourhood of Alberni village at the head of Alberni Canal. Gold-bearing quartz float was found by placer miners in China and Granite creeks, which resulted in the discoveries of bodies of auriferous quartz on Mineral Hill at the head of China creek as well as on the mountains near the head of Granite creek. The geologi-



ELK RIVER CAÑON, NEAR ELKO, EAST KOOTENAY.

cal formations are metamorphic schistose rocks and granites. Later prospecting demonstrated that the zone made up of these rocks was of comparatively limited width, and its length has never been determined. The trend of these rocks is northwesterly; the ore bodies fill fissures lenticular in structure with pay ore in shoots. The gangue is quartz, which at and near the surface is free-milling and carries gold values, but with depth the ore becomes refractory. Most of these mineral claims are situated from 10 to 15 miles from the eastern shore of the canal. The lack of transportation facilities has been sufficient reason for the closing down of active developement. But these discoveries proved an incentive to prospectors to exploit the shores of Alberni

canal, as well as those of the numerous bays or fiords which indent the west coast of Vancouver Island.

As a result from this work, there are today a very large number of mineral locations, many of which are very promising prospects containing usually chalcopyrite and sometimes bornite, situated in a zone trending northwesterly, which in some localities attains a width of twelve to fourteen miles and reaches from near the southern end of

PRINCETON, SIMILKAMEEN MINING DISTRICT.

the island at Sooke Harbor to almost the extreme northwesterly end at Quatsino Sound. The full extent of this zone, so far as width is concerned, has been determined at only a few points.

Southeasterly from the head of Alberni canal, but with its position northeasterly from the zone of auriferous free-milling ores referred to earlier in this article, occurs a zone of schistose rock on Mts. Brenton, Sicker, Richards, Malahat, and Skirt, which flanks on the southeastern side the cretaceous coal measures of the eastern portion of Vancouver Island, and contains the productive copper-gold mines. For while a great deal of attention has been devoted by prospectors and engineers to the prospects on the west coast of the island, only in a few cases has the developement been carried sufficiently far to place the mineral claims in the ranks of the shipping mines. But the district

locally known as the Mt. Sicker has been more fortunate, because, although occupying a far less extensive area, yet several mineral claims were acquired by enterprising companies whose management has carried on the development work so persistently since 1899 as not only to ship about 30,000 tons of high-grade copper-gold ore of an average value of $5.00 in gold and 6 per cent. copper per ton, but to show sufficient ore in sight to demonstrate that profitable smelting operations can be carried on by local smelters. Consequently two smelting plants are being erected on the east coast of the island, one at Osborne Bay about eleven miles distant from Mt. Sicker by rail, and the other at Ladysmith, about nineteen miles distant. The zone of schistose rocks in which occur the mines referred to is of undetermined extent longitudinally, but known to maintain continuity from the southeasterly coast of Vancouver Island from the vicinity of Saanich Inlet and Maple Bay across Mts. Malahat, Richards, Sicker, Brenton, and be-

SUNSET CAMP, BOUNDARY MINING DISTRICT.

yond these towards Alberni Canal. The distance it has been explored is some fifteen miles as the crow flies. The trend of the ore bodies is more westerly than northwesterly, and so far as at present known, there is no extension of this particular mineral-bearing zone beyond the Alberni Canal.

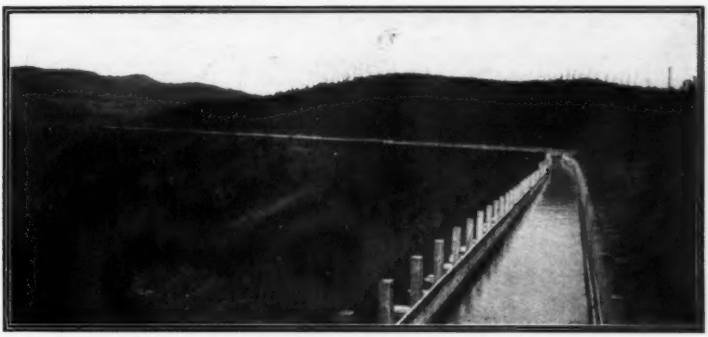
The width of the productive zone—so far as at present known—is about 1,200 feet, but discoveries have been reported of other parallel zones lying to the southwest, or rather southerly from the main one.

Northerly and northwesterly from the Mt. Sicker mines occur the areas of cretaceous rocks in which are found the coal seams of the eastern portion of Vancouver Island. These have been productive since about 1852 and have furnished the bulk of the coal used for domestic and steam purposes in California since that time. The coast from Ladysmith to Comox, a distance of nearly 100 miles, except a short break at Nanoose Harbor, is composed of these coal measures. The width is variable; probably the maximum is reached near Comox, where the measures extend for nearly twenty miles inland. Near Nanaimo the width is nearly as great, but at other points this is much less. Extensive collieries have been established and are in active operation at Extension, near Ladysmith, at Alexandria, Nanaimo, and Union, about twelve miles inland from Comox Harbor.

The islands in the Gulf of Georgia between Vancouver Island and the mainland, are as a rule, quite limited in area, and except Texada have not yet produced any metalliferous ores in commercial quantity, although mineral claims have been located on many of them, notably on Salt Spring, Thurlow, Valdez, and Redonda. The surface indica-

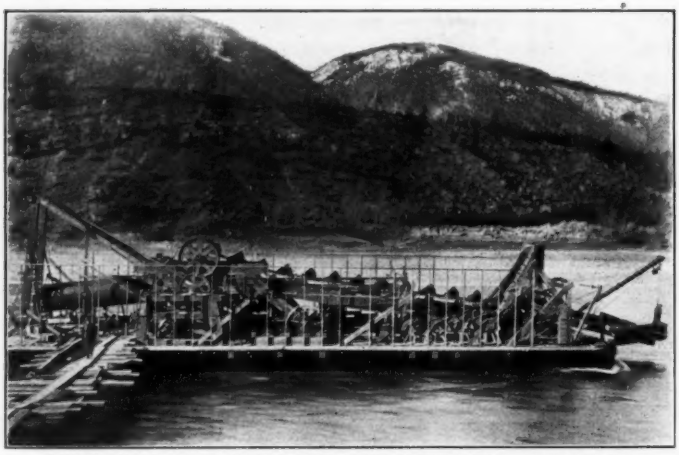
BREAST OF STOPE, 100-FOOT LEVEL, SUNSET MINE; BOUNDARY MINING DISTRICT.

tions which led prospectors to locate claims on these were very promising, but on none has sufficiently extensive developement work been done to determine the value of the prospects except on Texada Island, which is the largest in area and has produced nearly half-a-million dollars as the result of working the gold-copper ores found there. The island, considered geologically, is composed of crystalline lime-



FORTY THIRD COMPANY'S DITCH, KILDARE GULCH, OMINECA.

stone and igneous rocks. Mining operations have been confined to the northern end. Near the east coast deposits of bornite and chalcopyrite, the former carrying gold values sometimes as high as an ounce to the ton of ore in the three producing mines, and averaging about $8.00 to the ton in addition to the copper values, while the latter carries lower gold values but averaged 5 per cent. copper, from smelter returns from about 25,000 tons produced since 1899. The greatest depth attained on any metalliferous mine, either on Vancouver Island or the coast of the mainland, has been reached on the Copper Queen on Texada, where the working shaft is 515 feet deep. Bornite ore was found to predominate even at that depth, where the ore body was about 130 feet in length with a thickness of 4 feet on the foot wall, and a maximum of 12 feet on the hanging wall, with 13 feet of barren felsite, or possibly altered limestone, lying between the two bodies of ore. The ore bodies in the productive mines occur either in the limestone or felsite (as it is locally termed), or at the contact between these rocks: or else, but much more rarely, at the contact between limestone and diabase. The rock termed felsite, if subjected to an expert examination will possibly be found to be an altered impure limestone; it contains calcite, garnets, alumina, and silica, but may be a felsite of igneous origin and occur as intrusions in the limestone which has been thoroughly metamorphosed.



GOLD DREDGE UNDER CONSTRUCTION NEAR LYTTON ON THE FRASER RIVER.

The centre of this island is made up almost entirely of igneous rocks, many of which have a porphyritic structure, and these are often fissured. The veins so formed are filled with auriferous quartz, free-milling at and near the surface, but refractory and apparently in many cases losing their values at shallow depths. Consequently none of this class of ore bodies on Texada Island has as yet developed into permanent paying mines.

Near the northwestern coast of the island the crystalline limestone again occurs in vast bodies, and in contact with basic igneous rocks. The mineral resources of this portion are magnetite and limestone, the latter being burned and the product shipped chiefly to Hawaii as well as local markets, while the former is mined and at present shipped to the iron furnace at Irondale in the State of Washington, where it is manufactured into pig iron of a superior quality. The iron ore carries an average of about 70 per cent. metallic iron, and its content of phosphorus is well within the Bessemer limit.

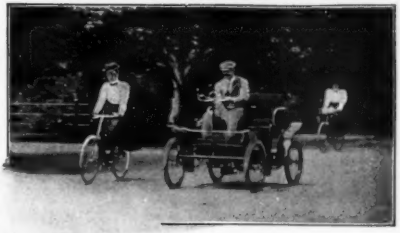
The southern portion of Texada Island has not been explored, chiefly because of the landing places even for small boats being very few and far between, while in the interior the heavy growth of timber, the density of the brush, and the precipitous mountains render exploration very difficult, even for professional prospectors.

NOTE:—The illustrations accompanying this article are from photographs, many of which were kindly loaned to the writer by the Department of Mines for British Columbia, and the remainder photographed by himself.

THE PARIS-VIENNA MOTOR-CAR RACES.

By C. R. D'Esterre.

The most striking effect of the noted Continental motor-car races is noted by Mr. D'Esterre in the article below. It is the perfecting of the cars mechanically through the necessity of meeting conditions of extreme severity in what might be called "intensified service." Such a result goes far to offset any charge of undue attention to "sport." It is akin to the more slowly worked out processes of evolution in other branches of mechanical industry.—THE EDITORS.

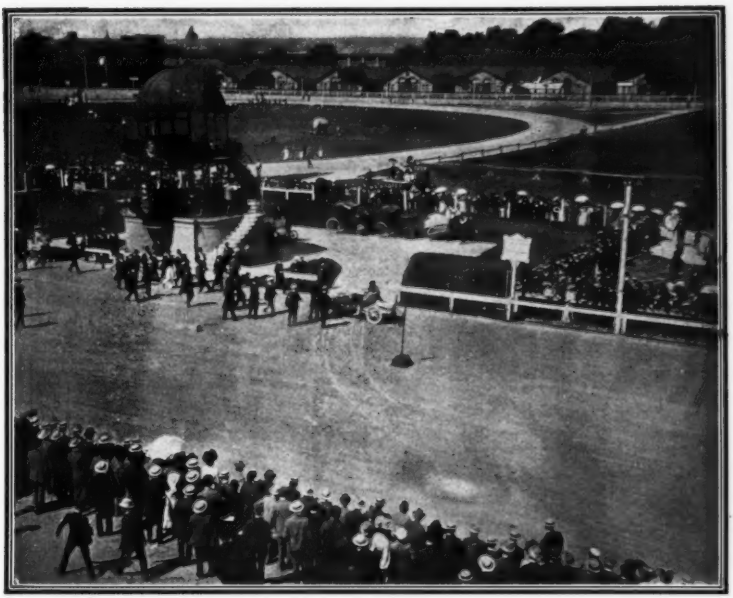


THE long-distance road races which during the past eight years have formed the central feature of automobilism in France, are undoubtedly largely responsible for the extraordinary developement which has taken place in the motor-vehicle industry in that country. To carry through one of these competitions successfully over even a few hundred miles of average macadam road demands that the vehicles shall have been brought to a state of at least tolerable practicability for everyday use; hence it was not until the internal-combustion engine of Daimler had been taken up by practical engineers and incorporated in a road vehicle, that these competitions were originated. It was in the early 90's, about 1892-94, that the reliability of the petrol cars constructed by the firms of Panhard & Levassor and Peugeot and fitted with engines of the Daimler type, led to the suggestion of running motor vehicles on the road under competitive conditions, and from the date of the first race from Paris to Rouen, 1894, those firms which have most energetically devoted themselves to the developement of vehicles especially designed to withstand the strains of these long-distance high-speed races have invariably retained their reputation as constructors of reliable vehicles for everyday use.

It is universally recognised among engineers that there is no test for any sort of mechanism better calculated to expose its defects than an organised competitive trial fixed for a definite date and time; and there is no combination of mechanism more liable to the unexpected

developement of mysterious troubles and derangements than the delicate internal organs of a motor vehicle. Hence it is that each year many a car entered by its contractors under the belief that it represents their highest efforts in the direction of perfection of mechanical parts, is taken back to the shops after a race, in a condition which teaches more valuable lessons than would have been gained by a year of ordinary use in the hands of a customer employing the vehicle for pleasure purposes. It reflects great credit on the automobile manufacturers of France, that each year they have accepted the responsibilities and difficulties involved by races made more and more difficult and destructive to their vehicles. Eight years ago they were invited to send their vehicles for a run of one or two hundred miles over the best roads that could be chosen in France; they might effect all necessary repairs on the road, and if fortunate in escaping mechanical trouble the cars might run through from start to finish without a stop and almost without slowing down. Nowadays, however, the successful competitors in a race are called upon to pass through an ordeal such as probably no other mechanical contrivance is ever subjected to. The race is not now over some road in France chosen for its straightness and the perfection of its surface, but it takes the most difficult route through three countries. It extends from Paris to Vienna, crosses Switzerland and the Tyrolean Alps, rises above the snow line, and descends by a torrent-washed track over which the automobilist must pass in danger of utter destruction at every turn before he can reach his destination. This route of 1,400 kilometres must be traversed in four days, at an average speed considerably greater than that maintained on the railways which pass through the same districts. The automobilist must slow down at almost every village, and must stop and re-start twice at the controls of almost every town. When he arrives at his destination for the night he must drive his car to a definite spot and there leave it without spending a moment for repairs or adjustment, which must all be done on the road on the following day and in time which counts against his running time. To crown all these difficulties, the constructor must put his car on the road in running order, to weigh not more than 1,000 kilogrammes (about 19½ hundredweight) in the heaviest class, and to enable it to compete with its rivals in point of speed it must carry an engine developing 50 to 70 brake horse power.

Carrying these conditions in mind, the success of the Paris-Vienna race can only be characterised as marvellous. In the first place it must be remembered that it is less than a year ago that the



SCENE ON THE ARRIVAL OF ONE OF THE CARS ON THE RACE COURSE, VIENNA.

Automobile Club de France decided to fix the 1,000 kilogrammes as the limit of weight of a racing vehicle. All the constructors of heavy cars have thus been called upon to remodel their vehicles entirely. The factor of safety has been cut down to the finest in every part, every item not absolutely essential has been rigorously excluded; and notwithstanding this the engine power per pound of total weight has been greatly increased. The constructors of vehicles in the classes limited to weights of 650 and 450 kilogrammes respectively have correspondingly been called upon to increase their engine power to a point which a year or two ago would have been considered high for a heavy car, in order to maintain a speed approaching that of the heavy vehicles; whilst the motor tricycle with its 11-brake-horse-power engine has been developed into a machine which can be likened to nothing but an enormous grasshopper as it leaps over the road at 100 kilometres per hour. The skill and intelligence with which the manufacturers have met the manifold difficulties of constructing cars suitable for the Paris-Vienna race is of the very highest order. Examining the vehicles of a few of the leading constructors our attention is

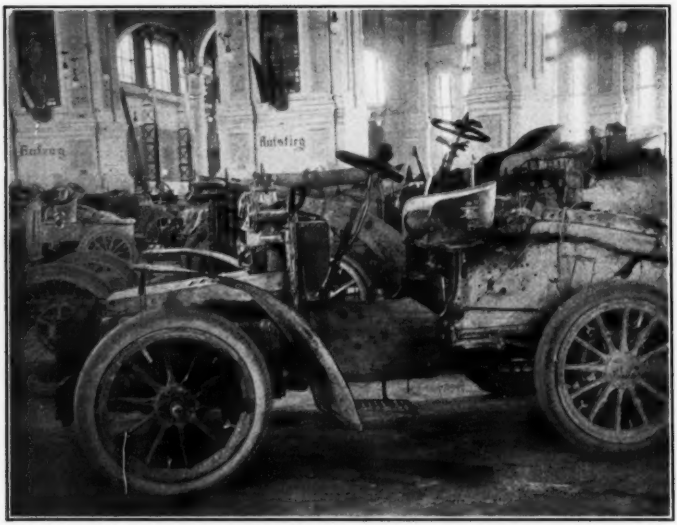
A 70-HORSE-POWER PANHARD WAITING THE START AT CHAMPIGNY, JUNE 26.

naturally in the first place attracted by the work of the Panhard & Levassor firm. In their latest type of cars, weighing only 960 kilogrammes, we find an engine which is stated on reliable authority to develope 70 to 75 brake horse power. The car is modelled generally on the well-known Panhard lines with four-cylinder vertical engine mounted toward the front of the underframe and transmission by spur, bevel and chain gearing to the rear road wheels; but in detail we find many modifications. The underframe, which carries all the essential items of the mechanism, is constructed of wood strengthened by suitably designed steel-plate girders, and is supported from the axles by three plate springs, two at the back parallel with the length of the frame, and one transverse spring attached centrally to the front cross member of the frame and pivotted at its ends from the front axle. The position of the front axle is preserved by light rods pivotted on the axle and on the longitudinal members of the frame. This front spring is extraordinarily light considering that it has to carry a full half of the total load, but its position is such as relieves it of one of the chief strains to which side front springs parallel to the frame would be subjected, namely, the continual rock of the engine in a plane at right angles to the length of the crank shaft due to forces entirely unbalanced. Weight has been saved in another direction

by making the axles tubular, and the ends of the front axle are now forked to receive the steering-wheel pivots. The engine, although still of the four-cylinder vertical type, bears no more resemblance to the original Phœnix Daimler engine than does a modern locomotive, to early productions of Stephenson. It has been subjected to a rigorous process of lightening. The four cylinders are now entirely independent, the castings which in each case constitute cylinder body and head being bolted independently to the upper half of the aluminum crank chamber. The water jacket for the body of each cylinder is formed of sheet copper. The valves and pipes, both for inlet and exhaust, bear a much more just proportion to the cylinder volume and piston speed than in earlier engines. In order to obtain sufficient opening for the admission of the gas to the cylinders, the admission valve is in each case triple, as in the English Napier engines of two years ago, the three small valves giving a much more efficient opening than one large one. The governing of the engine is effected by closing the admission to all cylinders alike. The carburettor is, as formerly, of the spraying type originally adapted to these high-speed explosion engines by Maybach. In the matter of relation of bore and stroke we find that, although the engine is still high and the stroke long for the speed aimed at, the Panhard, together with all the other

ONE OF THE 70-HORSE-POWER PANHARDS AFTER THE RACE.

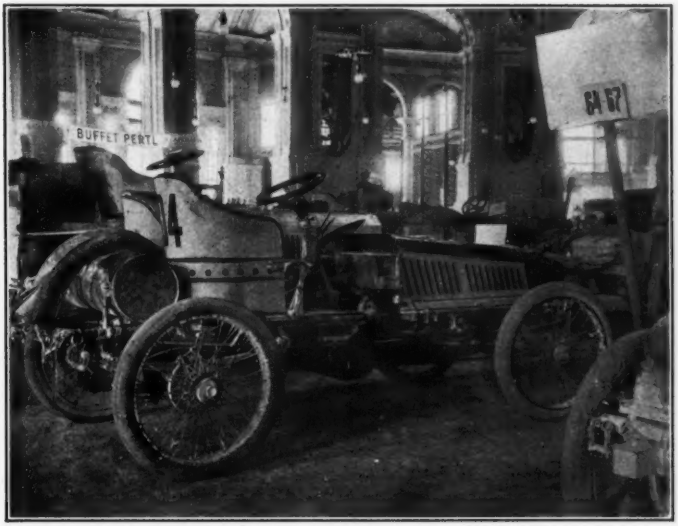
firms, are being driven to shorten the stroke of their engines in proportion to the bore according to the dictates both of theory and practice, in spite of an obstinate clinging to the idea that power is best obtained by applying the force of the explosion to a crank of long leverage. The ignition in the engine is now only electric, the hot tube having evidently disappeared for good. The water circulation is maintained by a friction-driven centrifugal pump, and the cooling is effected by one of the latest "Loyal" coolers in which a battery of 22 small pipes coupled in parallel, bent to form 9 layers in series, is sheathed in aluminum radiating ribs and formed to fit the front of the bonnet covering the engine. The transmission of power from engine to road wheels is effected by a combined friction cone and bolt clutch, the female portion of which forms part of the flywheel, while



THE CROUAN LIGHT CAR; THE ONLY RACING CAR WITH HORIZONTAL ENGINE TO ARRIVE AT VIENNA.

the male portion is mounted on an extension of the lower shaft of the change-speed gear. The main portion of the gear box is now mounted behind the differential cross shaft, but the general arrangement of sliding spur wheels on the lower longitudinal shaft driving fixed wheels on the upper shaft, which in turn drive the differential cross shaft of a single bevel gearing, is identical with last year's models. The cross shaft which carries the pinions of the final chain

drive is now constructed in two parts as necessitated by the differential gear, and not as formerly in four parts to allow of play between the gear box and the frame. The gear box is now so hung that strains on the underframe are not transmitted to the shafting. The final driving chains are extraordinarily light considering the power to be transmitted; five years ago chains as heavy as these were fitted to cars of 6 brake horse power.

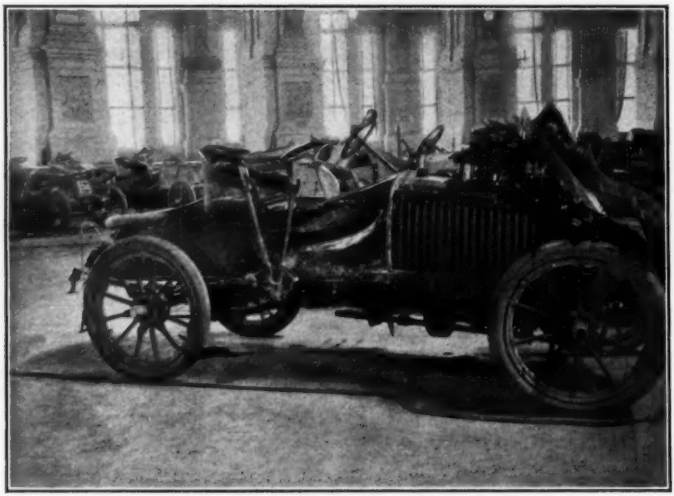


A DECAUVILLE LIGHT CAR AT VIENNA.

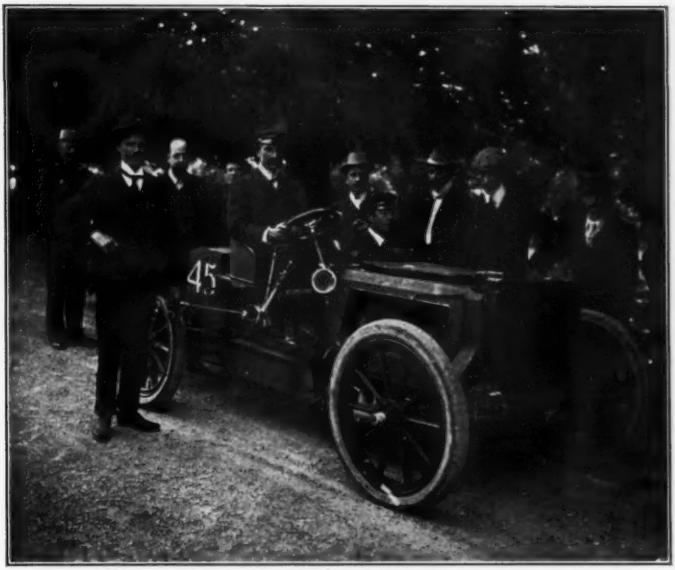
Many points of similarity are to be found between the vehicles of Mors and Panhard & Levassor, but the Mors firm, who carried off first honors in last year's Paris-Bordeaux and Paris-Berlin contests, had to face a much more difficult problem in remodelling their 1901 type, weighing about 1,400 kilogrammes, to reduce its weight to 1,000 kilogrammes, than had their rivals, whose type for last year weighed only about 1,150 kilogrammes. As the result of the Paris-Vienna race has shown, the problem proved too severe. Of the five Mors cars of 60 horse power which started from Champigny in the hands of the most expert drivers, two were wrecked by mischance, one by the severity of the road, and two arrived at Vienna but did not take very high places. An extenuating circumstance which must not be passed over unmentioned was that all these cars started practically untried. A point of great interest and ingenuity in the design of these Mors

cars is the air dashpots employed to aid the springs supporting the underframe. The pots of the dashpots are attached to the underframe whilst the pistons are coupled to the axles, the action being to accelerate the return of the road wheels to the road when they have been raised by striking an inequality and so to keep the driving effort more regular.

Amongst the heavy vehicles the performance of the Mercedes cars constructed by the Cannstadt Daimler firm was highly successful. Of four cars entered, two only started and these both driven by amateurs. These two cars were amongst the leading vehicles throughout and actually arrived at Vienna second and third, but in the final classification one was reduced to the fifth place whilst the other was disqualified owing to the fact that it had to be towed over the last four-hundred yards of the course owing to a temporary mechanical derangement. These Mercedes cars were of the same type as so successfully competed at Nice in the spring of this year and although not of an excessively high power—40 horse power—they had been thoroughly tested on the road side by side with the petrol and alcohol cars. The steam vehicles of Serpollet fitted with furnaces burning alcohol ran with conspicuous regularity, all the starters, five in number, arriving at Vienna. This performance is unique in the history of steam-propelled carriages.



THE WINNING RENAULT CAR IN THE ROTUNDA AT VIENNA AFTER THE RACE.



MR. S. F. EDGE ON THE NAPIER CAR.

In the categories of light cars and voiturettes we find a diversity of design too complex to admit of a detailed description, but the construction of the most successful vehicles, the Renaults and the Darracqs, will naturally attract especial attention. The fact that it was a light Renault car, weight 650 kilogrammes, which took first place in the whole race, whilst Darracqs of similar weight hold the third and seventh, eighth, and ninth places, speaks very eloquently for the really light car of moderate power as a vehicle capable of high speeds and possessing great endurance. The engines in both the above types of car are four-cylinder vertical, of high speed and stroke very short in proportion to the bore. The underframes are in both cases constructed of steel tubing and spring by single plate springs from tubular axles. The road wheels of the Renault cars have wood spokes and the Darracqs are of the steel tangent-spoke type. The transmission is in each case by a spur change gear and flexible tail shaft to a bevel gearing driving the live rear axle through the differential gear.

A car which is of especial interest to British automobilists is the Napier, which under the skillful guidance of Mr. S. F. Edge gained the Gordon Bennett cup, although in competition with the best cars and most skilled drivers that France could put upon the road. The

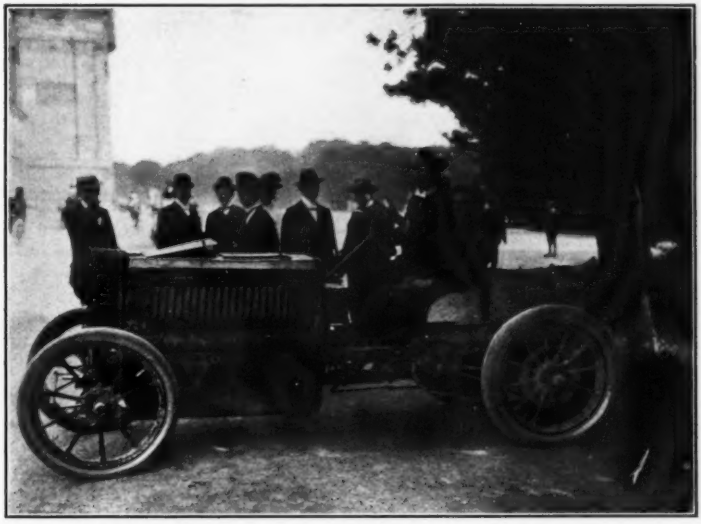
race for the Gordon Bennett cup was run over the same course and at the same time as the Paris-Vienna race, but ended at Innsbruck in the Austrian Tyrol, about 900 kilometres from Paris. The four cars competing in this race started first amongst the Paris-Vienna cars and numbered, for France a Panhard-Levassor of 70 horse power driven by M. René de Knyff, a C. G. V. car of about 60 horse power driven by M. Girardot, and a Mors car of 60 horse power driven by M. Henri Fournier, whilst England was represented by the Napier light car driven by Mr. Edge. The result of this race, as of the Paris-Vienna, was a triumph for the light car. At about 70 kilometres from the start the C. G. V. car gave way under the strain of excessive speed; at about 250 kilometres a similar fate awaited Fournier on his

A GROUP OF MOTOR BICYCLES. THE FIRST TWO ARRIVALS WERE WERNERS.

Mors, whilst R. de Knyff, the engine of whose car, it may be mentioned, ran on alcohol, when within 50 kilometres of Innsbruck and virtually holding the assurance of success, was put *hors de combat* by a broken differential. The cup thus fell to Edge, whose car travelled consistently well throughout, maintaining a good average although not a very high speed. The Napier car, which is the first English vehicle to be victorious in a Continental race, is a totally different design from the vehicles of the same firm which since the 1,000 miles trial of 1899 have occupied a prominent position amongst British cars.

It is of the category of light cars, and carries an engine developing about 35 brake horse power of the four-cylinder vertical type, high-speed and short-stroke, with very large pipes and valves.

As is almost invariably the case in these important races, there was a great disparity between the numbers of cars entered and the number of actual starters. Of about 210 entries, 137 cars were sent off from Champigny on the morning of June 26; of this number 106 arrived at Belfort, 408 kilometres from Paris, the end of the first



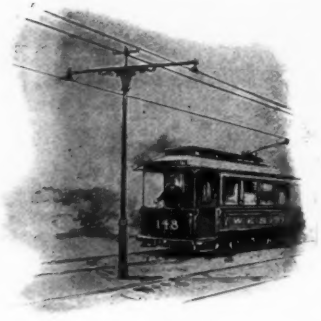
HENRY FARMAN ON HIS 70-HORSE-POWER PANHARD.

day's run, and of these 85 cars arrived at Vienna on June 29. Considering the severity of the course and of the rules regulating the running of the cars, this result reflects the highest credit on all connected with the construction and running of the cars. The average speed of the winning car is not very high—about 58 kilometres per hour—but it must be remembered that the cars were constantly losing time by slowing down for villages and stopping at controls; that the whole of the route through Switzerland was neutralised, and that all repairs and replenishments were effected in the running time. On the first stage, where the roads were good and the route fairly well-known, R. de Knyff on his 70-horse-power Panhard using alcohol fuel maintained an average speed of almost exactly 100 kilometres—62 miles per hour. An achievement such as this speaks for itself.

HIGH SPEED ELECTRIC INTERURBAN RAILWAYS.

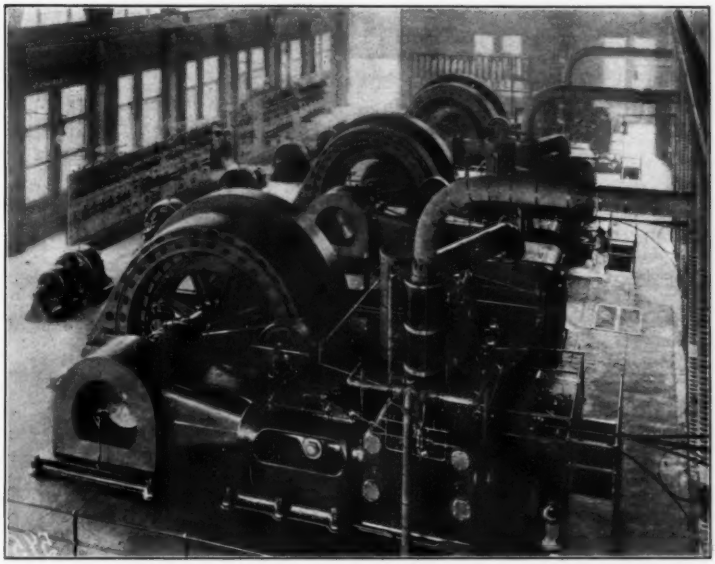
By George H. Gibson.

The most significant suggestion from Mr. Gibson's article is that the electric railway, with all the wonderful extension it has had in the United States, is hardly more than beginning its work as an economic influence. How far that work may extend it would be almost rash to attempt to say. But this much appears certain:—the electric road is an additional—not a substitutional—transport agency. It will supplement and modify the steam railway—force it to specialize on the service for which it is most fitted—but not supersede it. The work of the world is increasing so fast it seems to demand all available tools, seizing the new, but adding them to the old. There may, however, be many changes in relative importance. Electric motive power will be enormously greater in the total application ten years hence. Mr. Gibson's account of its proved fitness and extended use even at present will carry great interest and almost a revelation to many readers.—The Editors.



THE electric railway is to perform a service for mankind as notable and perhaps ultimately as great as that rendered by its steam-operated precursor. Already it handles the bulk of suburban and short-distance interurban passenger traffic; it carries freight, mail, express, and baggage; it operates at speeds reaching 60 miles per hour; its cars are operated on time schedules and dispatched by telephone; its roadbed is often as expensive and heavy of construction as that of the best steam lines; and, what is more interesting to the investor, it pays large dividends. At the present time $1,600,000,000 are nominally invested in electric roads in the United States and upon this sum $7,000,000 are paid in yearly dividends; 300,000 employees receive yearly in wages $250,000,000, and there are 20,000 miles of track on which 60,000 cars are run. In 1899, ten miles of electric road were built for every mile of steam road constructed.

The greatest development of interurban roads has taken place in the great agricultural districts of the middle western States, where they have grown to a truly surprising extent. It is often said that electric railways have checked the concentration of population in great

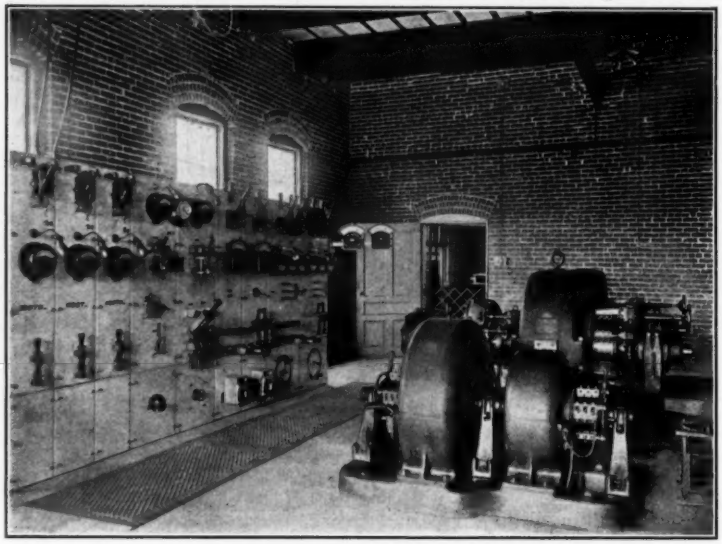


THREE 1,000-KILOWATT ROTATING-FIELD WESTINGHOUSE GENERATORS, THREE-PHASE, 3,200 VOLTS. UNION TRACTION COMPANY OF INDIANA.

cities by creating suburban districts, but in the farming regions they have had a still greater effect in building up many small centers of population. The Union Traction Company of Indiana operates 109 miles of interurban track and 54 miles of city track in the gas belt of that State and serves a population of 350,000. It connects the cities of Anderson, Marion, Muncie, Indianapolis and about twenty smaller towns and traverses six of the most prosperous counties of the State. The interurban lines are located almost entirely on private right of way protected by fences and cattle guards. Tests have shown that a maximum speed of 58 miles an hour may be reached and an average speed of 45 miles an hour maintained. Cars are run in each direction every hour and special cars are furnished for theater parties, excursions, and picnics. The rates of fare are approximately one cent a mile. The daily receipts of the interurban lines are said to be $3,000 on an average, but this is frequently increased to $8,000 and on one occasion was $11,000 in a single day. Large additions are contemplated, about doubling the present mileage. Power is generated in a central station at Anderson, containing three 1,000-kilowatt Westinghouse alternators, and is transmitted by three-phase alternating

current at 14,000 volts to eight sub-stations, which are supplemented by storage batteries.

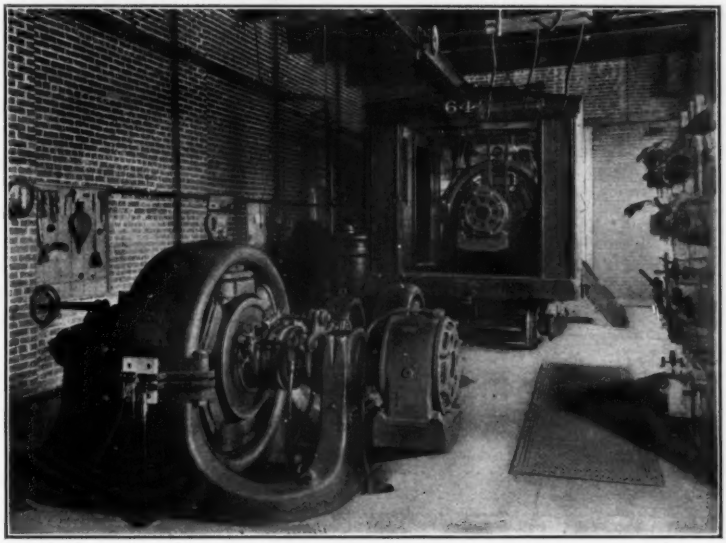
One of the greatest possibilities of the interurban road lies in the development of freight traffic. It is well fitted for the transfer of farm produce and supplies for farmers and for carrying package merchandise, and it can often give great convenience of delivery and the possibility of handling freight economically, especially in small cities. The Chicago, Harvard & Lake Geneva Railway has not only a large freight traffic of its own but carries on an interchange of busi-



250-KILOWATT THREE-PHASE WESTINGHOUSE ROTARY CONVERTER AND ALTERNATING-CURRENT—DIRECT-CURRENT SWITCHBOARD, ALEXANDRIA SUB-STATION, UNION TRACTION CO. OF INDIANA.

ness with steam roads, to a greater extent perhaps than any other electric road in the United States. Its southern terminus is at Harvard, on the Chicago & Northwestern Railroad, and at Walworth, 8½ miles north of this place, the road crosses the Chicago, Milwaukee & St. Paul Railway, thence running two miles northeast to Lake Geneva, one of Wisconsin's most popular summer resorts. One-third of the business of the road is in handling freight. Freight cars from the railroads are hauled to sidings on the electric road at a flat rate of $5 per car, and piece freight is transported on a one-rate plan between any two points on the road for five cents per hundred pounds, no

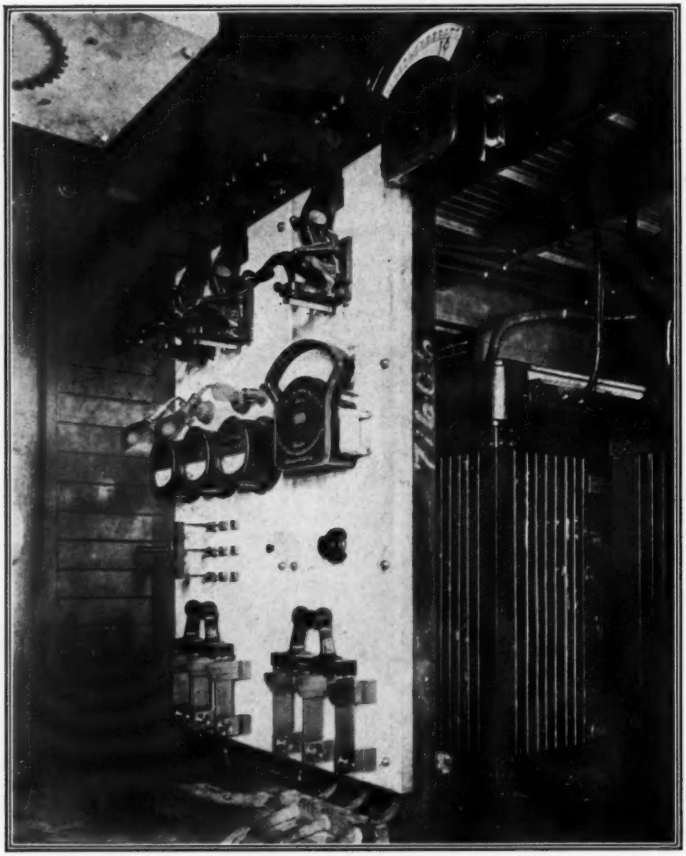
package being handled for less than ten cents. A freight motor car with a crew of two men carries package freight and hauls from one to four steam-road freight cars. There are six freight sidings along the road, not including the company's yards. Live-stock shipments are an important part of the business. In summer refrigerator cars are run twice a week over the Chicago & Northwestern Railway for the benefit of creameries situated on the electric road, and last winter 3,000 tons of ice were hauled from Lake Geneva for local use along the line. The company receives $500 per year for hauling mail two trips daily each way. Passenger tickets are sold by the electric road to points on the steam roads and baggage is carried free. The power house is located at Murray and contains two generators of 500 kilo-



PORTABLE WESTINGHOUSE ROTARY CONVERTER, RUNNING IN MULTIPLE WITH STATIONARY ROTARY, 250-KILOWATT THREE-PHASE.
Union Traction Co. of Indiana.

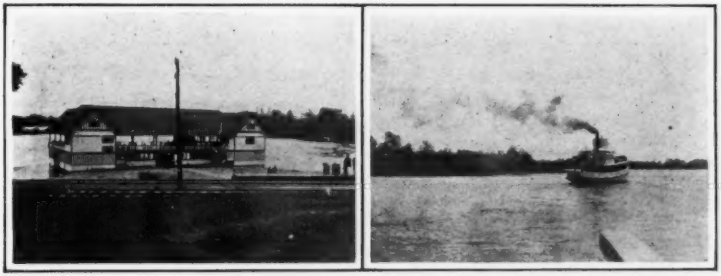
watts each. The equipment consists of ten motor cars and six trail cars. The maximum speed is 45 miles per hour.

While many electric roads have been constructed cheaply and of light materials, the tendency is more and more towards a substantial type of construction similar to the best steam-railway practice. The Grand Rapids, Grand Haven & Muskegon Railway, recently completed, is equipped with standard 70-pound T-rails laid on a private



INTERIOR OF PORTABLE ROTARY-CONVERTER CAR SHOWING SWITCHBOARD AND TRANSFORMER.
Union Traction Co. of Indiana.

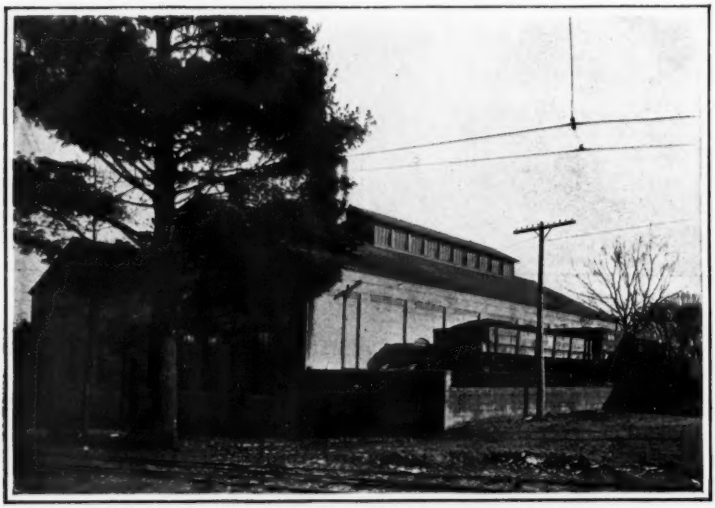
right of way. The road runs from Grand Rapids to Muskegon, Mich., a distance of 35 miles, with a branch 7 miles long to Grand Haven. It parallels steam roads to both cities, the running time of the electric and steam cars being about the same. The country is well developed industrially, containing tin-plate and paper mills, knitting factories, and machine shops. Grand Rapids has a population of 96,000, Muskegon 26,000 and Grand Haven 5,000. The country near Grand Haven is largely occupied as a summer resort by people from



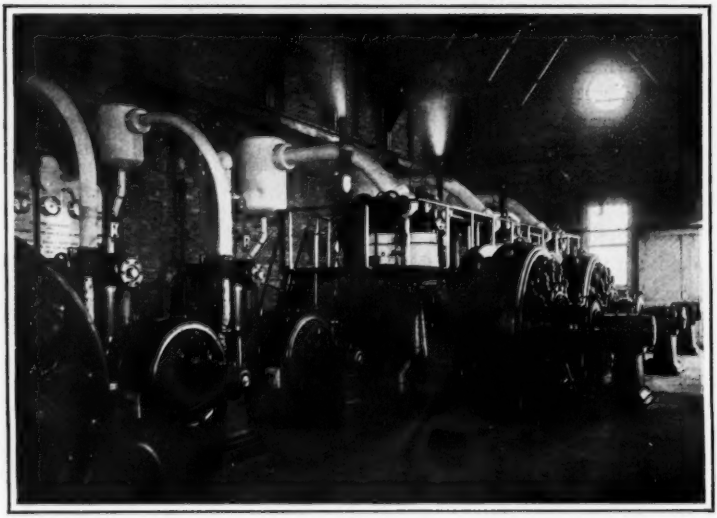
PAVILION AT FRUITPORT ON SPRING LAKE, AND STEAMER OTTAWA, OPERATED BY GRAND RAPIDS, GRAND HAVEN & MUSKEGON RY.

Grand Rapids, Chicago, and Milwaukee. In passing through towns and cities, the road uses the overhead-trolley system, for which the cars are equipped with a trolley arm, while upon the enclosed right of way through the country the third-rail system is employed. The third rail is discontinued at crossings, the current being carried under the highways by conductors imbedded in pitch in underground conduits. The conductor rail is of 65-pound section and standard composition, and is supported upon reconstructed-granite insulators. The power house, located at Fruitport, contains five 250-kilowatt generators, three of which are double-current machines, generating both direct and alternating currents, while two are standard alternators. All are direct connected to Westinghouse vertical compound engines and are arranged for operation in multiple.

Another interesting road running out from Grand Rapids is the Grand Rapids, Holland & Lake Michigan Rapid Railway, extending from Grand Rapids to Holland and there connecting with two short lines to the lake shore. This road traverses a rich farming country, thickly settled by Dutch and Germans, and the two lines to the lake shore reach a favorite summer resort district. The aggregate length of track of the combined roads is 71 miles, the total distance covered being 45 miles, 19 miles of this comprising the two roads running from Holland to the lake. Cars are operated on a headway of one hour and require at the present time 90 minutes for the trip from Grand Rapids to Holland. This time is to be reduced as soon as the roadbed is improved and a maximum speed of 45 miles will be realized, with an average speed of 26 miles per hour, including stops. All railroads are crossed by bridges and subways, and the private right of way, which is four rods wide, is fenced in. The entire mechanical and engineering construction has been carried out very thoroughly.



The track is standard gauge, laid with 70-pound T-rails, and is ballasted with coarse gravel and drained by vitrified tiling. The power



FRUITPORT POWER HOUSE, G. R., G. H. & M. RY. FIVE 250-KILOWATT WESTINGHOUSE GENERATORS.

The exterior view above shows arrangements for unloading coal.

plant embodies coal-handling apparatus, mechanical stokers, economizers, and forced draught. The two engines are of the vertical cross-compound condensing type and are direct connected to 500 kilowatt, three-phase, twenty-five-cycle alternators. The sub-stations at various points on the road are supplied with alternating current transmitted at 20,000 volts over aluminum conductors. The transmission lines are carried upon the poles supporting the trolley wire, the whole being protected from lightning discharges by a strand of barbed wire strung at the tops of the poles and grounded at each sixth pole to galvanized-iron pipes driven 12 feet into the ground. The cars are 47

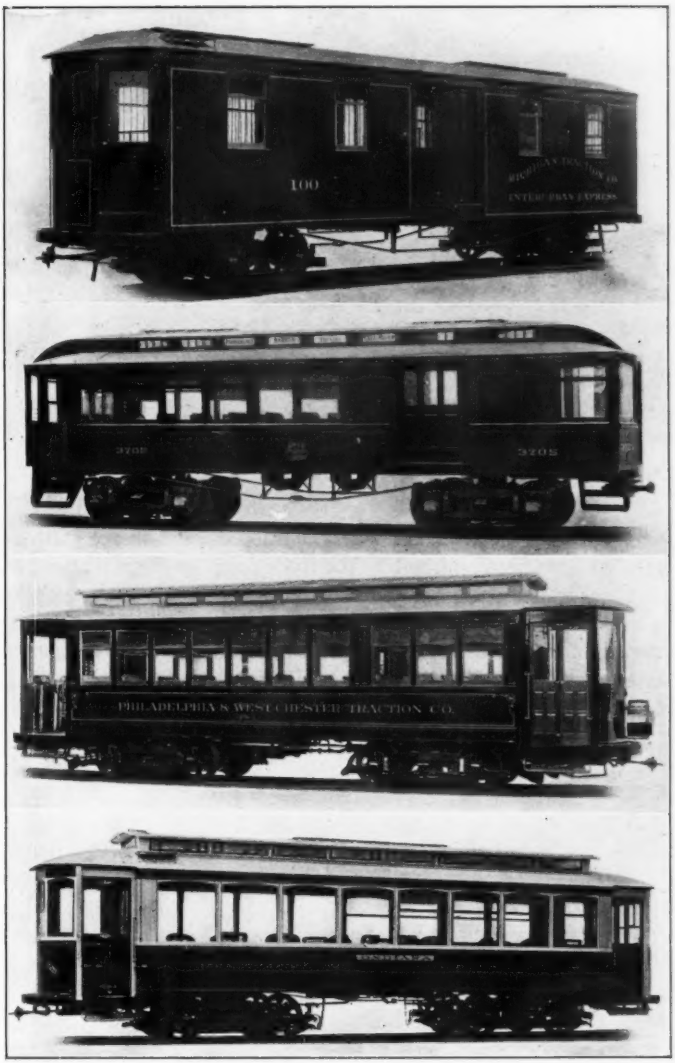
SUB-STATION, G. R., G. H. & M. RY., SHOWING THIRD-RAIL CONSTRUCTION.

feet long and weigh from 23 to 25 tons without load. They are completely equipped with heaters, air brakes, sand boxes, etc. The company has recently ordered a number of 50-foot cars and a number of 35-foot freight cars will be operated. The freight rates are low, ranging from 3½ to 23 cents per hundred pounds, depending upon a distance-rate basis and classification. The express rates vary from 20 cents for a package weighing not more than 10 pounds to 45 cents for packages weighing from 50 to 100 pounds, above which the rate is 45 cents per hundred. The franchise calls for rates not exceeding 1½ cents per mile for carrying passengers, but as the steam road paralleling the electric line has greatly reduced its fares since the building of the latter, the electric road has made special rates during certain

hours of the day when the steam-road trains are in operation between the terminal points.

While electric roads are approaching steam lines in type of construction and methods of operation, many of the latter are finding it advantageous to adopt electric traction, especially for short-haul and suburban service. The Quebec, Montmorency & Charlevoix Railway has in this way within two years increased its total yearly capacity and receipts from $44,221 to $73,292. The overhead trolley is used and the cars are equipped with two 50-horse-power motors and air brakes and are capable of running 45 miles per hour. The total cost of the electrical installation for 30 miles of track, including six double-truck cars and a 600-kilowatt alternating-current generating station, was $169,375. On Sundays and holidays the road is used so extensively that its resources are fully taxed and it has been found necessary to increase the rolling stock, so that in addition to the regular cars specials may be run at 10 and 15-minute intervals. It will further be necessary to construct a double track between Quebec and Montmorency. In addition to the electric traffic, steam, freight, and special pilgrimage trains are constantly handled, and no collision or other accident has so far occurred.

Another road which has greatly improved its service by adopting electric traction is the Buffalo & Lockport Railway. The company operating this road was organized in April, 1898, and leased for 99 years the Lockport Branch of the Erie Railroad, running from Lockport to North Tonawanda, N. Y., and comprising 13½ miles of single track. It has since bought 5½ miles of road in the streets of Lockport, 7½ miles of single track between Buffalo and North Tonawanda, and a mile of track in Buffalo, making the total length of the line at present 29 miles and giving through service from Buffalo to Lockport and Niagara Falls. Power is obtained from the Niagara Falls Power Co., and is transmitted at 10,500 volts to a rotary converter sub-station located at Lockport, from which it is fed as direct current at 1,500 volts to the trolley wires. Both passenger and freight traffic are handled, trolley cars being used for the passenger service and two electric locomotives, built by the General Electric Co., for the freight service. These locomotives weigh 36 tons each. Since the road is a feeder of the Erie Railway system, the freight traffic is considerable and the locomotives are each equipped with four 160-horse-power motors, designed to give a draw-bar pull of 3,400 pounds when running at 15 miles per hour, which is considered sufficient to handle a 340-ton train. The locomotive trolleys are controlled from the cab by means of a



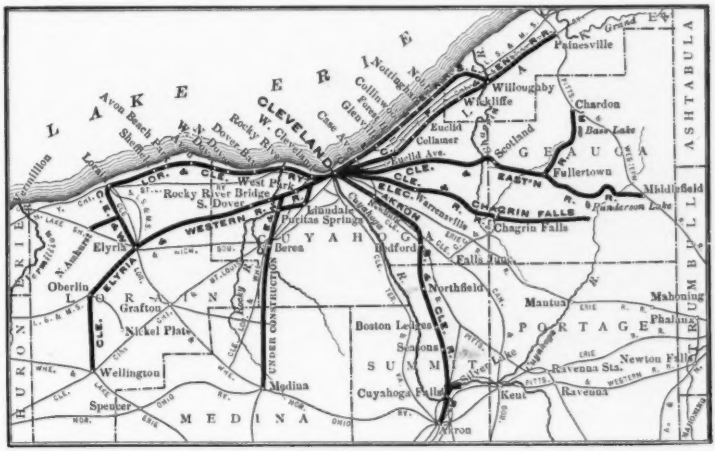
TYPES OF MODERN AMERICAN CARS FOR HEAVY ELECTRIC-RAILWAY SERVICE.

At the top is a 40-foot express car, weighing 25,000 pounds, open from end to end for load; diagonal doors to take in long pieces; speed 33 miles. Next comes a 40-foot trolley car with baggage compartment, Providence & Fall River branch of N. Y., N. H. & H. Ry.; weighs 45,000 pounds; seats 28 passengers. Below that is a 41-foot 25,000-pound car with 9-foot smoking compartment, intended for average speed of 20 miles. At the bottom is a semi-convertible parlor trolley car for the Buffalo railway, 41 feet 8 inches long, 31,000 pounds. All by the J. G. Brill Company.

LOCOMOTIVE FOR THE BUFFALO AND LOCKPORT RAILWAY. GENERAL ELECTRIC CO.

pneumatic arrangement. The most marked change on the road, however, has been accomplished by the trolley cars in connection with the passenger traffic. The equipment includes five cars which are operated on a half-hour headway. Each car is equipped with four 52-horse-power motors and a maximum speed of more than 60 miles per hour has been reached. The trip between Buffalo and Lockport, a distance of 25 miles, can be made in one hour, including stops. The cars are 31 feet long and have two passenger compartments, one of which is a smoker. In addition to the regular passenger car, one combined baggage and passenger car is operated, carrying mail and express.

A number of roads used chiefly for pleasure riding have been built in Southern California in the neighborhood of Los Angeles. The population is composed largely of wealthy people who have sought that part of the country on account of climatic conditions, and who patronize the roads liberally. One of the roads from Los Angeles extends to Pasadena and from there to Echo Mountain and Mt. Lowe. Another line runs from Los Angeles to Santa Monica on the Pacific Ocean. The Los Angeles-Pasadena line was so well patronized the first year that it was necessary to double-track the road. It competes with three steam lines, and one of the latter has been compelled to reduce its train service by half and would reduce it still further if that were not prevented by its franchise. The cars on the Pasadena line are each equipped with two 40-horse-power motors and Standard air brakes, and make a maximum speed of 25 miles per hour. The road to


LAKE ERIE
CLEVELAND
Painesville
Willoughby
Wickliffe
Chardon
Euclid
Collamer
Bass Lake
GEAUGA
Fullertown
Middlefield
Randerson Lake
ASHTABULA
CLE. & CHAGRIN FALLS
Chagrin Falls
WESTERN R.
Elyria
Berea
Rocky River Bridge
S. Dover
Edgewater Park
West Park
Euclid Ave.
Scotland
Collinwood
Nottingham
Glenville
Case Ave.
Lorain
Avon Beach
Sheffield
Rocky River
W. Cleveland
Dover Bay
Willowick
Lake Shore
Col. C.
Lake Shore
Lorain
Elyria
Oberlin
Grafton
Nickel Plate
Wellington
Spencer
Medina
Columbus
Cincinnati
Indianapolis
Chicago
Pittsburg
Buffalo
Toledo
Detroit
Cleveland
Akron
Canton
Pittsburgh
Erie
Mansfield
Crestline
Galion
Delaware
Marion
Columbus
Zanesville
Wheeling
Parkersburg
Huron
Sandusky
Norwalk
Fremont
Bellevue
Tiffin
Findlay
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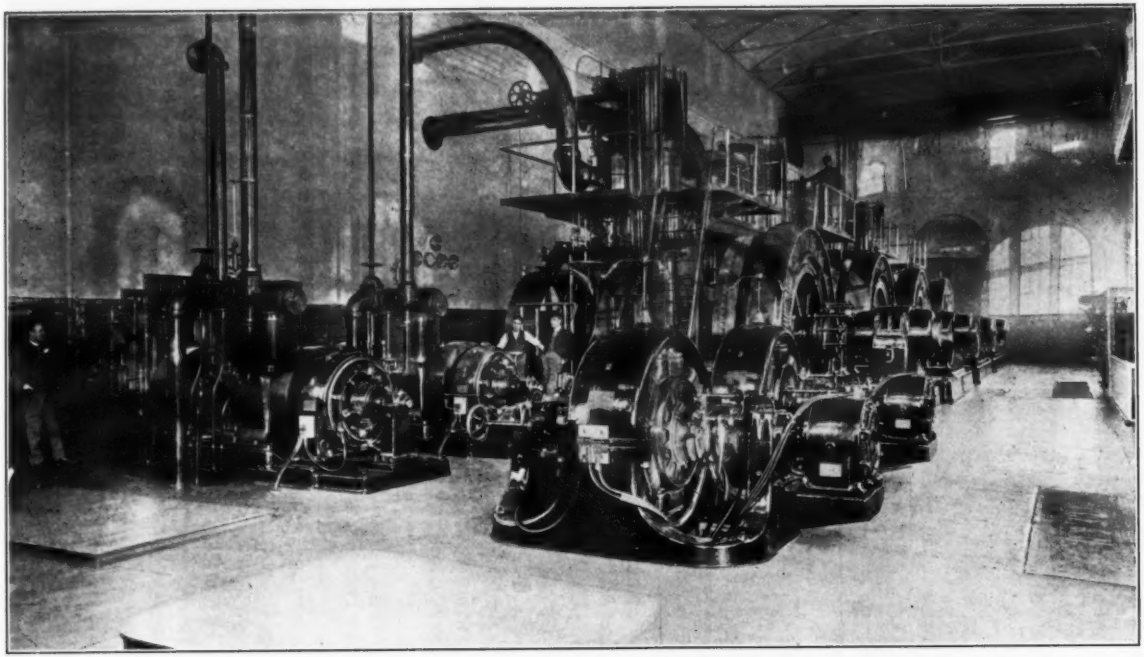
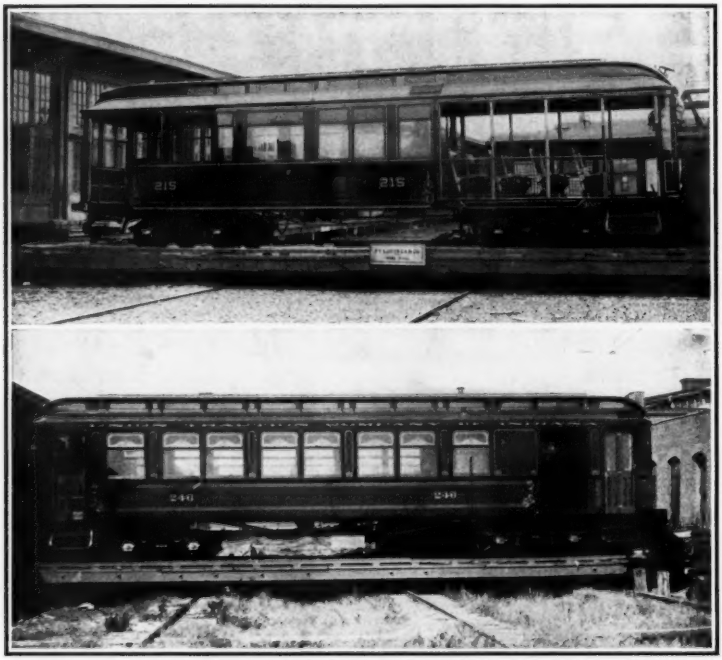


INTERIOR OF ENGINE ROOM, TOLEDO, FREMONT & NORWALK RAILWAY CO., FREMONT, O.
Four alternating-current generators direct-connected to 1,750-horse-power Westinghouse engines.

in the United States to be equipped with steam turbines. Two Westinghouse turbines running at 1,500 revolutions per minute are to be direct-connected to two 1,000-kilowatt, two-pole generators, delivering alternating current at 400 volts and 25 cycles per second. Steam will be supplied to the turbines at 150-pounds pressure and 200-degrees superheat, and the exhaust will be under a 28-inch vacuum. The steam consumption is guaranteed not to exceed 10.8 pounds of steam per horse-power-hour; and at one-half load the steam consumption per horse power is not to increase more than 15 per cent. These turbines are somewhat novel in construction in that the steam is expanded consecutively in two chambers—that is, the steam first passes through a high-pressure cylinder, then through a reheater, and finally through a low-pressure cylinder. The rotating parts of both the high- and low-pressure cylinders are upon one shaft, the bearing being placed between the two cylinders. Full load may be carried without superheat or vacuum. The adoption of steam turbines has increased the possible capacity with the space available in the existing power house from 2,000 to 5,000 kilowatts. Two 300-kilowatt rotary converters are being installed as connecting links between the present direct-current plant and the alternating-current apparatus. The power is transmitted to sub-stations along the road by alternating current at 20,000 volts.

Cleveland is the center of an extensive interurban electric railway system, extending in one direction nearly to Buffalo, N. Y., and in the other to Toledo, Ohio, which is also the terminus of a large number of roads. One of the roads connecting Cleveland and Toledo is the Toledo, Fremont & Norwalk, about 60 miles in length and controlled by the Lake Shore Electric Company. The power house at Fremont, about the middle of the line, contains four alternating-current generators, direct connected to 1,750-horse-power Westinghouse steam engines. Current is transmitted at 16,000 volts to six sub-stations, which are combined with passenger and freight stations in order to cut down the cost of attendance. The high-tension transmission wires are carried upon the poles supporting the trolley brackets. The roadbed, partly upon private right of way and partly upon public turnpike, is constructed for speeds exceeding 40 miles per hour. In preparing for a through service between Cleveland and Toledo, a series of experiments are being made by the Lake Shore Electric Company with a view of determining the most desirable motors for the traffic. A cross-country schedule of 35 to 40 miles per hour has been established and a speed of over 60 miles per hour has been maintained for short distances. Some of the cars are fitted with four 100-horse-power elec-



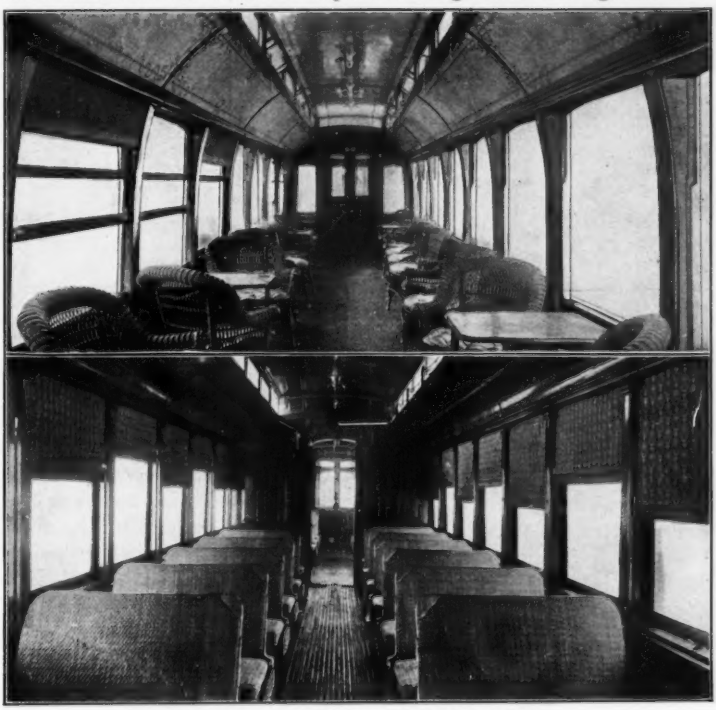
THE UPPER CAR IS FOR THE PACIFIC ELECTRIC RAILWAY, LOS ANGELES, CALIF.; THE LOWER ONE IS A MOTOR CAR FOR THE UNION TRACTION COMPANY OF INDIANA.
St. Louis Car Company, St. Louis, Mo.

tric motors. The cars now in service on the Toledo, Fremont & Norwalk are equipped with 75-horse-power Westinghouse motors. That part of the Lake Shore Electric Company's line between Cleveland and Norwalk is entirely on private right of way and is rock-ballasted and laid with 75-pound T-rails. This company is making an especial effort to develop freight traffic in fruit and dairy products. Passenger mileage books are sold for $12.50 per 1,000 miles, and local fares are about one-half of those charged by steam roads.

Toledo and Detroit are connected by a series of electric roads, one of the most completely equipped of which is the Toledo & Monroe Railway, having 18 miles of single track laid with 70-pound T-rails and ballasted with broken limestone. The equipment consists of ordinary passenger cars, chair cars, combined passenger and baggage cars, and freight cars. The passenger cars are 40 feet long and a regular schedule speed of 30 miles per hour, including stops, is maintained.

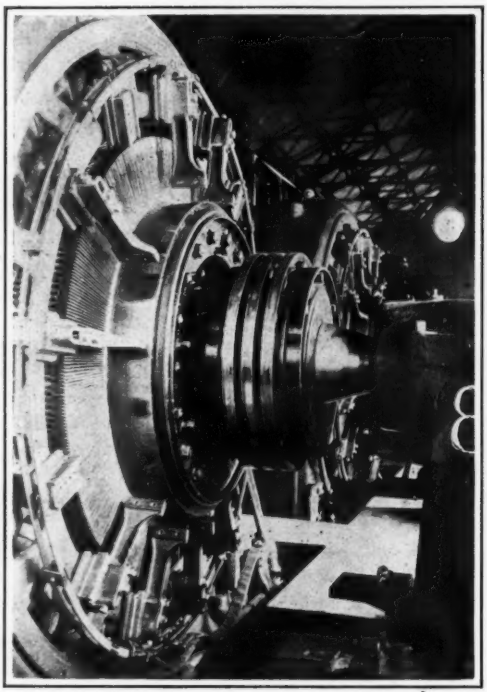
The power house contains two 400-kilowatt Westinghouse three-phase alternators and a sub-station contains a 200-kilowatt rotary converter. The long distance transmission is at 15,000 volts, the wires being carried on 45-foot pine poles set 6 feet in the ground and surrounded by concrete so that no guy wires are necessary. The same poles support the double trolley wire.

One of the oldest high-speed roads in America is the Detroit, Ypsilanti & Ann Arbor Railway. As originally constructed this road had a length of 50 miles, 40 miles between Detroit and Ann Arbor with a branch line of 10 miles to Saline. The line has recently been considerably extended, now reaching to Jackson, Mich., where it connects with other interurban roads. It is composed of single track throughout. The



INTERIORS OF ADVANCED TYPE TROLLEY CARS.

The car above is the "Ondiara," shown in exterior view at the bottom of page 867. Below is a 46-foot 35,000 pound car for the Chicago & Joliet Railway. It has a 14-foot smoking compartment and toilet room against the partition. Maximum speed 70 miles per hour.

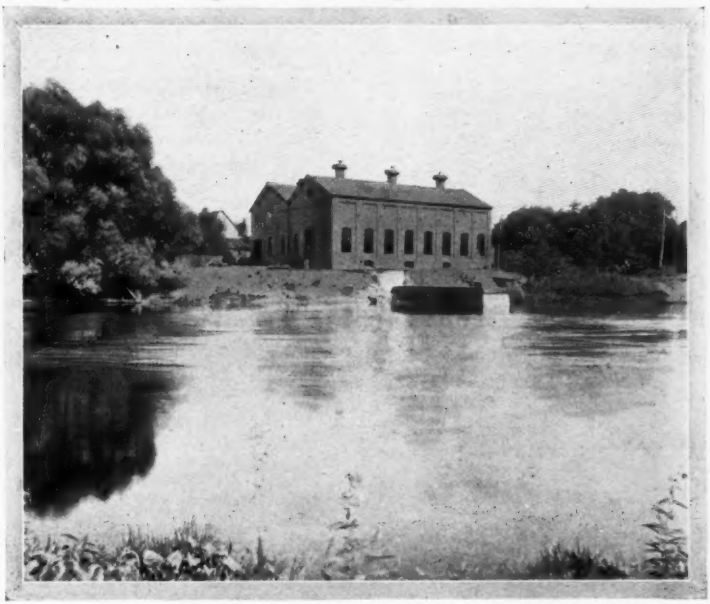


DOUBLE CURRENT WESTINGHOUSE GENERATORS, POWER HOUSE OF DETROIT, YPSILANTI & ANN ARBOR RAILWAY.

equipment consists of 20 cars, each provided with four 50-horse-power motors and quick-acting air-brakes. The motors can all be thrown in series for slow speed through cities. A regular half-hour service is maintained with an occasional 15-minute service, and all cars are dispatched by telephone, telephone stations being located at turnouts. The most remarkable effect of this road has been the development of an enormous passenger traffic. During the first year 4,000 passengers were carried per day, against 200 previously carried per day by the steam road passing through the same towns. The fare for 40 miles is 50 cents, while the fare charged by the steam roads for the same distance is $1.12. A 1,000-mile mileage book is sold for one cent per mile. The average fare per passenger is 15.9 cents. Many houses are being built in the small towns along the route and market gardening is rapidly developing in the country traversed. Freight service is given twice a day and express packages are carried in the baggage compartments of the passenger cars. When the line was first opened, more freight was offered than could be carried, although the rates were two-thirds more than those asked by the steam-railroad company.

Extending north from Detroit 73 miles to Port Huron, Mich., and comprising in all 110 miles of single track exclusive of sidings, are the lines of the Rapid Railway Company, another early pioneer in the elec-

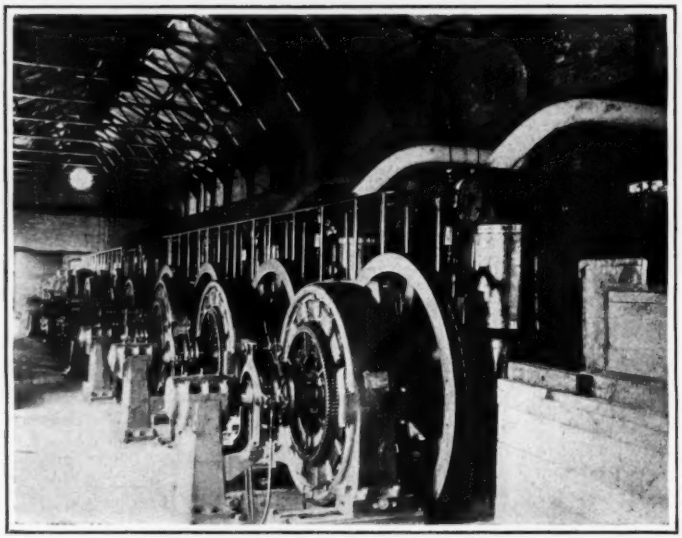
tric interurban railway field. This road is an excellent illustration of the great advances in the building of electric roads made possible by high-tension power transmission. All power is generated at a main station at New Baltimore and transmitted in either direction by alternating currents at 16,500 volts. The power house is equipped with all the latest improvements in the way of coal and ash-handling machinery, mechanical draft, economizers, etc., and contains three 1,000-horse-power Westinghouse steam engines all direct connected to



EXTERIOR OF POWER HOUSE, DETROIT, YPSILANTI & ANN ARBOR RAILWAY, YPSILANTI, MICH.

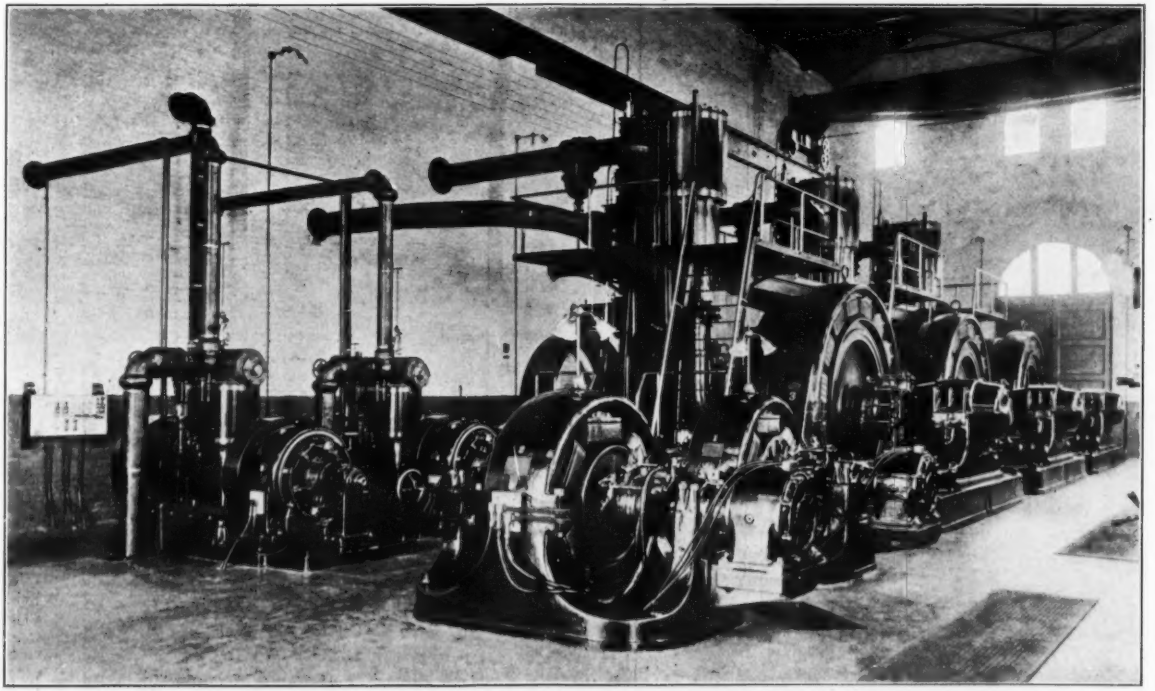
three-phase generators. There are five rotary-converter sub-stations, —two north of, two south of, and one at the power house. This railway passes through a rich agricultural country and at its middle part through a noted summer-resort district, which is rapidly being built up in consequence of the transportation facilities furnished by the electric line. About the same fares are charged as upon the Detroit, Ypsilanti & Ann Arbor Road, and arrangements have been made for an extensive freight traffic in fruit, fish, vegetables, groceries, and general merchandise. It is said that 50 per cent. of the lighter trade going to Detroit is now carried by the electric road. The cars are run on train

dispatchers' orders, telephone stations being placed at all sidings. After leaving the city limits of Detroit there are no grade crossings and the track is thoroughly well-laid and ballasted. One of the branches of the road closely follows the shore of Lake St. Clair and the northern part of the road follows the St. Clair River, passing through many fishing, hunting, and boating resorts. Hourly service is given regularly over the whole line and cars are operated at shorter intervals between points where traffic is dense. The schedule time for the cars is 27 miles per hour, including stops, and between stations the speed reaches 45 miles per hour.



YPSILANTI POWER HOUSE, D., Y. & A. A. RAILWAY.

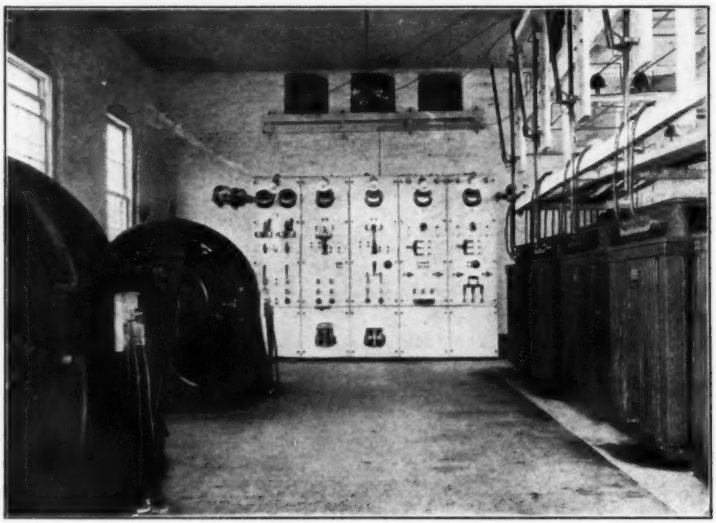
Another interesting Michigan road is the Houghton County Street Railway, located in the copper mining region of the Upper Peninsula. The line is 16½ miles in length and is constructed on a private right of way. It extends from Houghton to Calumet and Wolverine and serves a total population of 51,000. The interurban lines are single track with turnouts about two miles apart. Cuts are avoided, the ties being laid on an embankment which is in no place less than three feet above the level of the surrounding country, this precaution being necessary in order to avoid snow-drifts. As a further measure the equipment includes a rotary snow-plow, three Taunton heavy-nosed plows, and three snow-scrapers. Railway tracks are cleared by five wooden tres-



MAIN POWER STATION OF RAPID RAILWAY CO., NEW BALTIMORE, MICH.
Three 1,000-horse-power Westinghouse engines direct-connected to Westinghouse three-phase generators.

tles, the maximum grade being 7½ per cent. The roadway is laid throughout with 60-pound T-rails on cedar ties. The company operates sixteen closed cars having straight sides and vestibules with folding doors, and, because of their length equipped with trolley poles at each end. On account of the shortness of the summer season, no summer cars are used, but the windows of the closed cars are wide and low. The business of this road has been very large and in order to handle the summer travel it is probable that some of the rolling stock will be equipped with multiple train-control apparatus so that two-car trains may be operated. The power house is located at Hancock, where coal may be received at the company's dock. The power-house equipment consists of a Westinghouse 500 kilowatt, railway generator, a 500-kilowatt, 25-cycle alternator, and a 250-kilowatt rotary converter with two other converters of the same size at sub-stations.

In the state of Michigan there are twenty-four interurban lines actually in operation and franchises have been asked for forty-seven more. The great activity in building electric roads in this territory is due, perhaps more than to anything else, to the fact that it was here that a number of the earliest and most successful roads in the country



TWO 250-KILOWATT THREE-PHASE WESTINGHOUSE ROTARY CONVERTERS; SHOWING ALSO FOUR OF THE SIX OIL-COOLED RAISING TRANSFORMERS AND DIRECT-CURRENT SWITCHBOARD. HOUGHTON CO. STREET RY. CO., HANCOCK, MICH.

MOTOR CAR ON THE ALBANY & HUDSON RAILWAY, GENERAL ELECTRIC CO.

were constructed, thus bringing the possibilities of electric traction before the eyes of business men and capitalists.

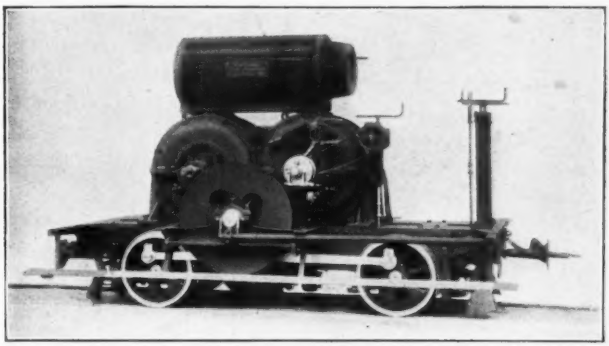
While the middle west has been the scene of the most active electric railway building in the United States, considerable progress has been made in some of the more thickly populated eastern States. At Hudson, N. Y., begins a long electric railway system which extends a distance of 105 miles to Warrensburg, near Lake George, running for a great part of the way along the Hudson and through a semi-mountainous country and giving a view of the Catskills and the Berkshire Hills. The first 37 miles is covered by the Albany & Hudson Railway, a small part of which is operated by trolley and the remainder by the third rail system. Except through city streets the company owns its own right of way, which is fenced in and laid in a very substantial manner. Both running and conductor rails are of T section and weigh 80 pounds to the yard, the third rail being somewhat lower in carbon than the service rails in order to reduce the electrical resistance. The track has been heavily ballasted and the ties are laid two feet center to center, every fifth tie being extended to support the third-rail insulators. The latter are supported six inches above the tie and are made of wooden blocks topped by malleable cast-iron caps or chairs. At all highways

and farm crossings the third rail is interrupted, but the continuity of the circuit is not broken. Power is supplied from a hydraulic plant at Stuyvesant Falls on Kinderhook Creek, about ten miles north of Hudson, and is transmitted by three-phase current at 12,000 volts to three sub-stations along the line, where it is transformed to direct current at 600 volts. The water-power station has a total capacity of 4,000 horse power and is relayed by a steam plant of 2,750 horse power, there being in all five generators, all built by the General Electric Company. The car equipment consists of five winter passenger cars, two combined passenger and baggage cars, two express cars, and a number of summer cars. The passenger cars are 53 feet long and seat sixty people. They are provided with two trolley poles at each end of the car and two pairs of contact shoes to operate on the third rail. A special switch placed on the platform allows the motormen to throw the controller upon either pair of contact shoes or upon the trolley, leaving the other devices "dead." This is necessary since the shoes are raised and lowered by hand at the junctions of the third-rail and the trolley sections. The summer cars are each equipped with four 50-horse-power motors and the winter cars with four 75-horse-power motors. The road is operated according to standard steam-line practice, the cars being controlled by telephone, or by telegraph in case of emergency. At Hudson this road meets the lines of the Hudson Valley Railway Co. operating over 100 miles of road and running north from Albany and Troy to Saratoga, Lake George, and the Adirondacks. At the present time, power for operating this road is derived from several independent power stations located at Stillwater, Saratoga, Middle Falls, Glens Falls, and Caldwell, but ultimately power for operating the entire system will be developed on the Hudson near Waterford.

In view of the high-speed experiments with three-phase motors that have recently been carried on in Germany, it is gratifying to note that similar experiments with direct-current motors are shortly to be made in America. The Aurora, Elgin & Chicago Railway has been designed for a continuous maximum speed of 70 miles per hour and the track is of such substantial character and easy alignment that higher speeds can be attained. The service rails are to weigh 80 pounds to the yard, the track is to be rock-ballasted, and all bridges will be of concrete and steel construction. The third rail is to weigh 100 pounds to the yard and is to be supplied with direct current from sub-stations, to which power will be transmitted at 26,000 volts by three-phase alternating current over aluminum feeders. The schedule speed will be 40 miles per hour, including stops at stations three miles apart.

Cars are to weigh 40 tons and are to run at a maximum speed of 65 miles per hour with a possible 70 miles per hour on a level track and with normal voltage on the third rail. The cars are to be operated either singly or in trains and are to be equipped by the General Electric Company.

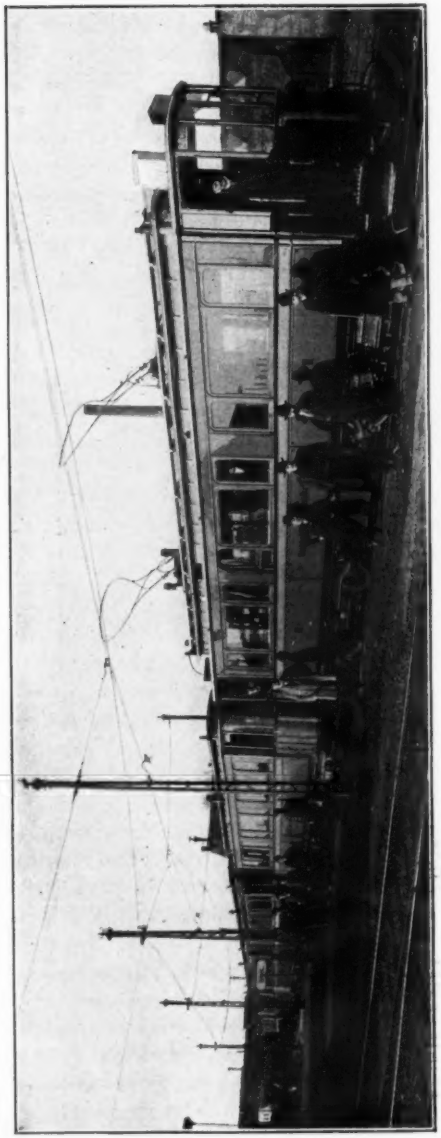
This paper might seem unduly partial if no mention were made of European roads. However, of high-speed interurban roads in Europe there are extremely few. In Great Britain it can truthfully be said there are no high-speed electric roads at all. The difference between America and Europe with respect to the development of electric traction is very strikingly shown by the following figures: The miles of electrically operated railways are, in the whole world outside of the



STANSSTAD-ENGELBERG ELECTRIC LOCOMOTIVE BEFORE HOUSING.

United States, 4.64 per million people; in Germany, the highest of Continental countries, 41.8 miles; and in the United States, 276.2 miles. It is said that the new plant of the Manhattan Elevated Railway Company, of New York City, which will have a total power of 40,000 kilowatts, equals in capacity the total electric power available for traction purposes in France. The United States has 76 per cent. of all the electricity available in the world for traction, 76½ per cent. of the electric-railway mileage, and 83½ per cent. of all the trolley cars.

A German steam road upon which electric traction has been tried is the Wannsee line between Berlin and Zehlendorf. Since August, 1900, an electric train has been interspersed in the regular service, a speed of about 25 miles per hour being maintained. The train weighs 193 tons empty and 220 tons loaded, and is composed of ten coaches, the first and last having three motors each of an aggregate capacity of 975 horse power. It runs 225 miles per day, the maximum speed being

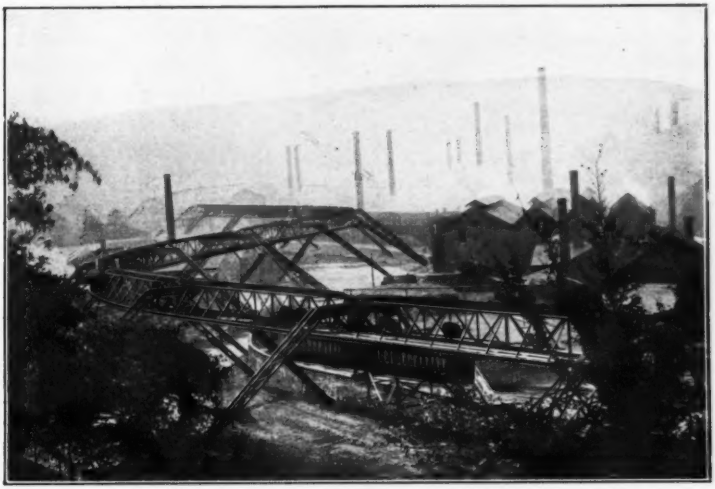


DÜSSELDORF-KREFELD ROAD WITH CARS WHICH RUN AT SIXTY KM PER HOUR.

31 miles per hour. Direct current is used at 750 volts. The efficiency of the power transmission between switchboard and axle was found to be from 70 per cent. to 85 per cent. The government railroad authorities have decided to discontinue the electric service, but the failure of the road has been due more to half-hearted measures than to any defect in the system.

The first installation of a high-speed electric road in Europe was between Düsseldorf and Krefeld, a total distance of 13.6 miles, the longest stretch between stopping places being 10.4 miles. Since the road parallels the steam railway for the greater part of its length, it is considered necessary to maintain a speed of 25 miles per hour on the open stretches. A speed of 37.2 miles per hour has been reached on trial trips. The road does not pass through the intervening towns but only touches the outskirts. It is double-

tracked form Düsseldorf to Oberkassel, the terminus of the Düsseldorf local traffic. Direct current is used at 600 volts pressure and the cars are mounted upon double trucks, each truck carrying a 40-horse-power



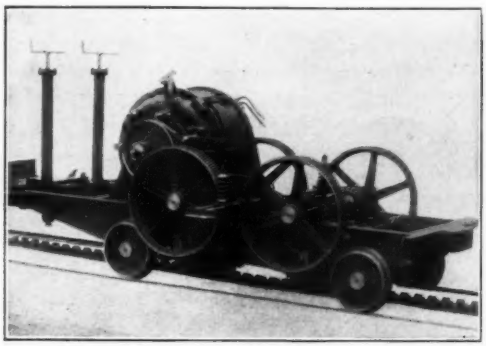
SUSPENDED RAILWAY AND TRAIN AT ELBERFIELD.

motor. The passengers are divided into three classes, the total seating capacity of a car being 34. Three kinds of brakes are used, viz., hand brakes, electric short-circuit brakes, and Standard air-brakes, and each motor car is also equipped with two trolley poles. Trains leave each terminal station every half-hour. The road has developed a quite considerable freight and farm service.

A road which has attracted considerable attention by its novel and unique features is the suspended railway at Elberfeld-Barmen, where the cars are hung from a single rail without any side guards or supports, so that in going around curves the cars may assume an inclined position. Of the eight miles originally planned, only 4½ have been built. The speed of the cars is from 12½ to 14 miles per hour. The switching construction is highly interesting but is not considered safe and is used only by empty cars.

The Swiss* roads are very interesting because of the original engineering methods which they embody. Most of them are mountain roads and are provided with rack rails. They are largely patronized

* The important electric installations of Italy were reviewed at some length by Signor Enrico Bignami in THE ENGINEERING MAGAZINE for November, 1900. For this reason they are omitted from Mr. Gibson's summary.—THE EDITORS.



TRUCK OF THE GORNERGRAT LOCOMOTIVE.

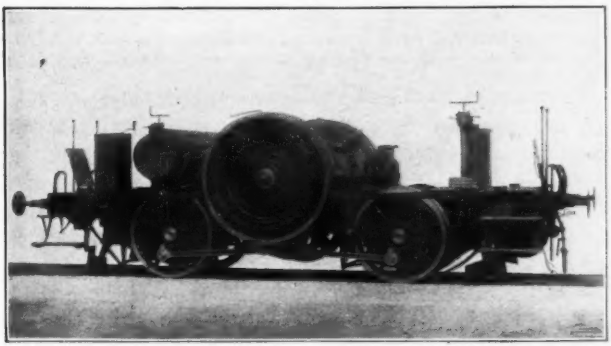
by tourists and charge very high fares. The road starting at Zermatt and ascending the Gornergrat has a maximum grade of 20 per cent. and is composed of curves throughout 30 per cent. of its total length, which is 5.7 miles. The entire roadbed was cut from solid rock or built upon projections. The rack system is of the Abt type. The locomotives weigh 10 1/2 tons each and are equipped with two motors having an aggregate of 90 horse power and operating at 500 volts. The speed is only 4 1/3 miles per hour, and double-reduction gearing is used. In addition to the two spindle brakes, one operated on the rack wheels and the other on the surface wheels, there is an electric brake which comes into action as soon as the speed of 4 1/3 miles per hour is exceeded. The motors are of the three-phase induction type with wound rotors and collector rings, and in coasting they may be used as extra brakes by inserting resistance in the rotor circuit.

The longest (25 miles) Swiss three-phase railway is the Burgdorf-Thun road, opened in 1899. The standard trains weigh 56 tons and have a maximum speed of 22 1/2 miles per hour. Current is transmitted at 16,000 volts, which is stepped down, by means of transformers located at an average of two miles apart, to 750 volts for distribution to the trolley line. The cars carry four trolleys, two at each end of the car. The equipment consists of two two-axle locomotives and six four-axle motor cars, with a number of trailers for passenger and freight traffic. The total power of the locomotives is 300 horse power. A small transformer is installed on each locomotive or motor car for lighting, heating, and driving an air compressor, Westinghouse air brakes being used. At present only five trains are operated on the line at any time. The fare for the entire 25 miles is 40 and 60 cents for the two classes.

The Stansstad-Engelberg Electric Railway has a total length of 13.8 miles, of which about one mile is rack construction. Three-phase

current is supplied to the trolley line at 750 volts, at which voltage most of it is generated. The trolley line is protected by Westinghouse lightning arresters. The rolling stock consists of three locomotives and seven motor cars weighing 14 tons and seating 46 persons.

Perhaps the most remarkable of the Swiss railways is the Jungfrau line which runs for 1 1/4 miles along the base of the mountain and then ascends by means of a tunnel, 6 1/3 miles long, to an altitude of 13,435 feet. After leaving the terminal station, the passengers are raised a further 240 feet by an elevator. The grade is 25 per cent. along the entire road, with the exception of a 2.2 mile section which has a 67 per cent. grade. The rolling stock consists of five locomotives, ten passenger cars, and two freight cars. The locomotives in reality form the rear truck of the cars, but can only be used without the latter. Three independent brakes insure safety during the descent. The locomotives are equipped with two three-phase motors, having a normal capacity of 25 horse power each, and the speed is 4¾ miles. The forward motor is coupled to a continuous-current dynamo, which serves to excite both motors during the descent, thus turning them into gen-

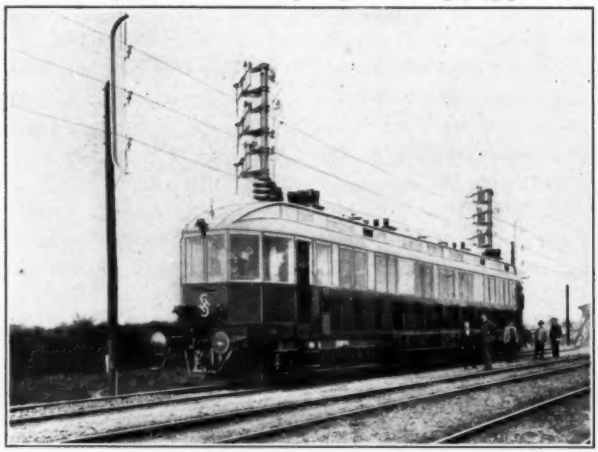


THREE-PHASE LOCOMOTIVE, BURGDORF-THUN ELECTRIC RAILWAY.

erators. There are but few days when the summit presents a clear view of the surrounding territory and the traffic is, therefore, concentrated in a very short time, when the rush is very great, and at such times eight trains per day operate.

The Berlin-Zossen high-speed electric-railway experiments are already so well known to the engineering public that I shall give here only a few of the most pertinent facts. These experiments were carried on by a company known as the Studiengesellschaft für Elektrische Schnellbahnen over a single-track standard-gauge road, which was laid

with 75-pound T-rails upon wooden cross ties and ballasted with cut stone. The total length of the line is 13.7 miles and the minimum radius of curves 3,300 feet, the steepest grade being 5.43 per cent. The



EXPERIMENTAL HIGH-SPEED CAR, MARIENFELDE-ZOSSEN LINE.
Showing details of trolleys, tracks, and general arrangement of the railway designed to run at 140 miles an hour.

test car was designed to seat 50 passengers and its total weight of 207,880 pounds was carried upon two trucks, each having three axles. Two of these carried motors of a normal capacity of 250 horse power and a maximum capacity, when starting, of 750 horse power. The conducting system was three-phase, operated at 10,000 to 12,000 volts and 45 to 50 cycles per second. Three trolley wires were placed vertically, one above another, contact being made by three bow-trolleys carried upon a vertical spindle. A transformer on board the car reduced the voltage to 1,150 while running or 1,850 while accelerating, at which pressures current was supplied to the motors.. The latter were governed by means of resistances cut into the secondary circuit, the resistances being placed in flat boxes along the two sides of the car, which were provided with gills to produce a circulation of air. The motors were designed to run at 900 revolutions per minute and were mounted directly upon the axles of the car wheels, the latter being 49 inches in diameter. In the trials a speed of 100 miles per hour was reached, but it was found impossible to go above this speed on account of the condition of the track. The results, however, were entirely successful as far as the equipment of the car was concerned, and higher speed could easily have been made had the roadbed permitted it.

RECORDING AND INTERPRETING FOUNDRY COSTS.

By Percy Longmuir.

Reference has been made many times in this Magazine to the frequent neglect of the foundry, and to the large influence which it nevertheless may have on the economy of the machine shop. This, of course, is more particularly true of the actual work of moulding, melting, and casting. But the foundation of all improvement is the analysis of present conditions, and if we begin with an accurate study of practice as it is, we shall not stop far short of discovering practice as it should be. Mr. Longmuir's article, therefore, though concerned more particularly with the commercial side of foundry management, has a strong practical interest for the machine-works manager also. Mr. Carpenter's article on cost keeping for the machine shop, concluding his series begun in February, has been unavoidably postponed by the serious illness of the author. It will appear in our next issue.—The Editors.

USUALLY, the method of estimating the labour cost of castings is to divide the total labour charges as shown in the wages book by the output of the foundry and so obtain a cost factor per ton or per hundredweight. Such a method can be satisfactory only when the work produced is of a uniform and unvarying character. This would be the case if the castings produced were all moulded by one method, as for instance, all green- or all dry-sand, and were of fairly uniform weight. But in the ordinary foundry the methods of moulding practised usually include green-sand, dry-sand, and loam, and in many cases machine and plate moulding. The castings so produced may range from those of several tons down to small ones of an ounce or so each. Obviously, then, the plan of dividing total labour cost by total output can yield only an average cost factor. This average cost factor may serve as a very fair guide if the various classes of castings bear a constant relationship to the output—a supposition hardly tenable in the case of the average foundry; for instance, loam casting may predominate one week, green-sand another, which again may be followed by a period in which dry-sand work forms the greater portion of the output. Further, in using an average method for the purpose of estimating cost it is quite possible that the good features of one section may be neutralised by the bad ones of another section; for example, the dry-sand and machine-moulding sections may be making an excellent margin of profit, whilst the green-sand and loam sections are working at a loss. The good work of the profit-making sections is thus lost sight of or swallowed up by the non-profit-producers, and

assuming that the profit made by the former be such as when distributed over the whole to show fair working, then the backwardness of the latter may escape detection for a considerable period.

In urging that a more detailed analysis of costs be adopted for all branches of foundry work, I do so entirely from the foundry manager's or foreman's point of view; and further—this analysis, if actually made in the foundry, will possess the greater value and be the more readily accessible to those directly concerned.

A form of labour-cost analysis often adopted is shown in Figure 1.

Week Ending February 16th, 1902.

OUTPUT OF GOOD CASTINGS=38½ TONS.

	CLASS OF LABOUR	WAGES	COST PER CWT.
1	Furnacemen	£9 8 8	£0 0 2.94
2	Labourers	25 0 10	0 0 7.80
3	Dressers	14 8 8	0 0 4.49
4	Moulders	73 10 0	0 1 11.00
5	Clerks, Timekeeper, etc	10 4 0	0 0 3.17
6	Foundry Foreman per cent	11 17 10	0 0 3.70
		£144 10 0	£0 3 9.10

Labour costs per ton, £3 15 2.

FIGURE 1. ORDINARY FORM OF COST ANALYSIS.

This form is—from a foundry manager's point of view—defective in that it does not indicate the cost of various classes of moulding nor the apportionment of the charges due to labourers—that is to say, items number 2 and 4 do not yield the information they should do.

The output represented on this table is that of a foundry doing no machine or plate moulding and engaged on a general class of work in green-sand, dry-sand, and loam moulding, none of which, however, is of an exceptionally heavy character. Dividing the work into representative classes and apportioning the unskilled labour as employed by each class, and taking the weight produced by each class, we get the hundredweight cost as in the following table. Owing to inherent difficulties, the core making could not be distributed in this manner and it is therefore regarded as a factor of the whole output. Item number 6—that of general labouring—includes such labour as is not directly chargeable to one class of moulding; of this there is always a fair amount in every foundry; it is essentially labour from which all classes of moulding benefit, but not necessarily proportionately.

		WAGES		WEIGHT PROD'C'D		COST PER CWT	
CLASS OF WORK		MOULDERS	LABOURERS	TONS	CWTS.	MOULDING	LABOURING
1	Loam	£7 10 0	£3 12 0	5	8	£0 1 4.6	£0 0 8
2	Dry Sand	20 0 0	4 10 0	13	7	0 1 6.0	0 0 4
3	Green Sand	32 6 0	5 8 0	16	3	0 2 0.0	0 0 4
4	Apprentices	3 10 0	18 0	3	12	0 0 11.7	0 0 3
	Totals	£63 6 0	£14 8 0	38	10	£0 1 7.7	£0 0 4.5
5	Core Makers	£10 4 0	0 18 0	38	10	0 0 3.3	£0 0 0.3
6	Gen. L'bour'g		9 14 10	38	10		£0 0 3.0
		£73 10 0	£25 0 10	38	10	1 11	£0 0 7.8

FIGURE 2. DETAILS OF MOULDING COSTS.

Assuming that such detailed analysis be adopted with each week's output of the foundry, then the man in charge has exact information laid before him, week by week, as to the cost of the work produced. He can at once put his finger on any branch in which costs are beginning to creep up, and if a remedy is required he knows exactly where to start its application.

Figure 3 represents a series of costs so obtained over a period of four weeks, and plotting these graphically the results shown in Figures 4 and 5 are obtained.

	I	II	III	IV
MOULDING	s. d.	s. d.	s. d.	s. d.
Loam	1 4.6	1 7	1 3.5	1 5
Dry Sand	1 6	1 9	1 5	1 7
Green Sand	2 0	2 2	2 1	2 0
Apprentices	11.7	1 3	1 0	1 1
LABOURING	s. d.	s. d.	s. d.	s. d.
Loam	8	10	7	8
Dry Sand	4	5	4.5	5
Green Sand	4	4.5	3.5	4
Apprentices	3	2.5	3	3.5
Core Making	.3	.2	.2	.4
General Labour	3	4	3	3.5
Melting	3	3.5	2.5	3.0

FIGURE 3. DETAILS OF LABOUR COST PER CWT. FOR PERIOD OF FOUR WEEKS.

These charts illustrate most forcibly the value of graphic repre-

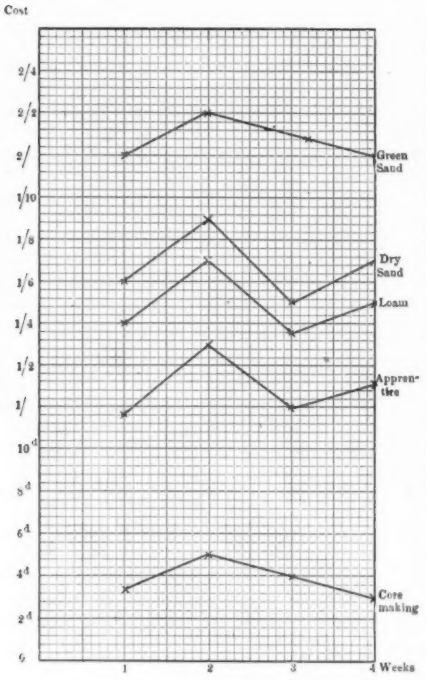


FIGURE 4. GRAPHIC PLOTTING OF FOUR WEEKS MOULDING COSTS.

sentation, and to the busy foundry manager a chart so prepared will serve to direct his attention instantly to the department really requiring it. The success of this detailed analysis and graphic representation lies in the fact that it instantly and almost automatically directs the attention of the responsible man to the weak places of his department. The labour involved in preparing them is not at all excessive and can be readily done at a trifling cost by the clerical staff of any foundry.

This of course must be regarded as distinct from prime cost—that is to say, the cost of individual orders for such work very properly belongs to the accounting side of the management and the details of them are seldom worked out until too late to be of service to the foundry manager. Then, further, prime-cost details are often worked out on the time records kept by the man working on the orders so treated. To be of real value, cost information supplied to the foundry manager must be given on the completion of every pay, whether these be weekly, fortnightly, or monthly, and this can be most readily done by grouping the men into classes according to the variety of their work, weighing the product of each class, and getting a cost factor from the wages paid. Experience will readily give standard factors for each class of work, and these standards may be plotted on the chart as a fair curve (straight line), the departures from which of the actual weekly cost line will instantly show the degree of good or bad working.

Should any difficulty lie in the adoption of the foregoing system of weekly detailed cost factors—as, for instance, where the wages books

are not made up in the foundry office, or where they are not accessible to the foreman or his clerk—then an output chart may be plotted each week which to some extent will show the conduct of the department.

It is recognised that the capital invested in the buildings and equipment of any foundry demands a definite return, and in this case the return may be very conveniently regarded as the production of a certain weight of castings each week. The weight necessary to yield this return may be arrived at by a careful survey of past working for as extensive a period as possible. A higher output is recognised as good working, and a lower one is fixed which represents the amount necessary to meet all charges and keep just on the margin of profitable production. These three figures, once estimated, may be regarded as comparative standards, and in the accompanying charts are distinguished as good working, caution, and danger lines.

Figure 6 shows the weekly output of a representative brass foundry. In this case a turn-out of 80 hundredweights per week is essential to meet all charges, 90 hundredweights produce a fair profit, and 100 hundredweights yield what may be regarded as an essential or requisite profit. The three abnormal points represent broken weeks due to stoppages for holidays.

Viewing the matter in the light of output only, it is readily apparent that a foundry may be producing castings at a very low cost and yet be working at a decided loss. Thus if the output is constantly below the danger line, no matter how low the cost of production be, the establishment is working at a disadvantage. Taking an extreme view, an establishment fitted to produce 50 tons of castings per week and only turning out one ton will be working at a loss, even if that single ton is produced for noth-

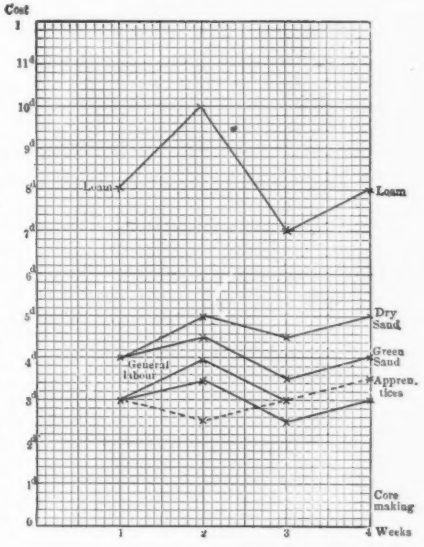


FIGURE 5. CHART SHOWING FLUCTUATION IN FOUNDRY-LABOR COST OVER A PERIOD OF FOUR WEEKS.

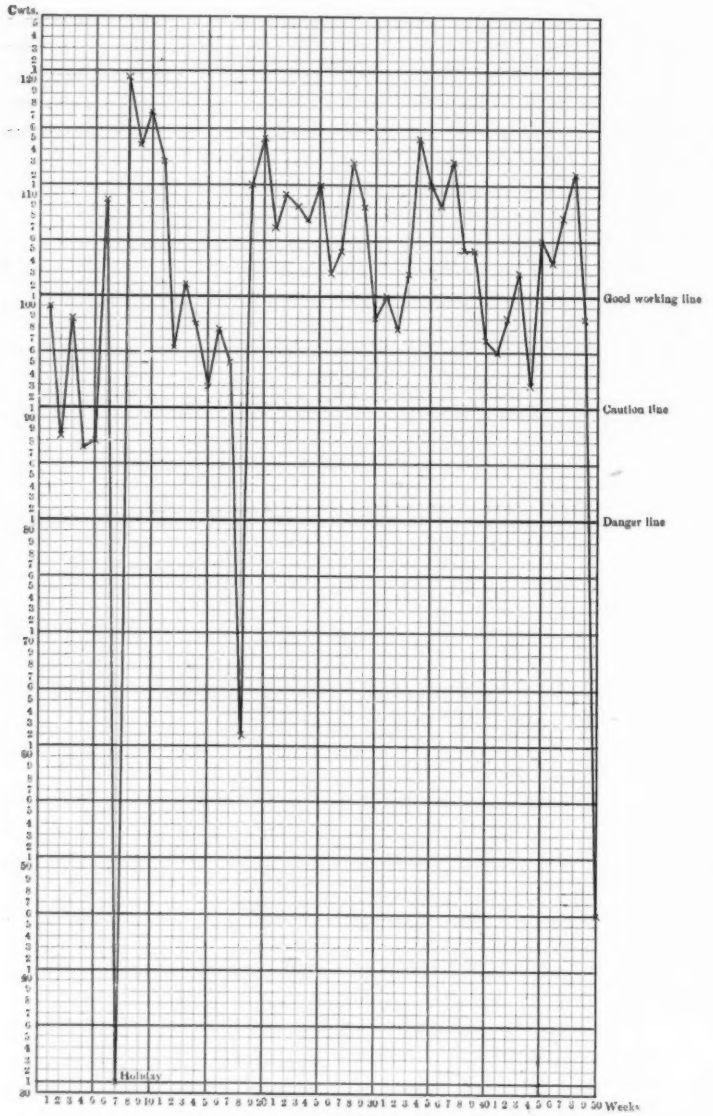


FIGURE 6. WEEKLY OUTPUT CHART FOR A REPRESENTATIVE BRASS FOUNDRY.

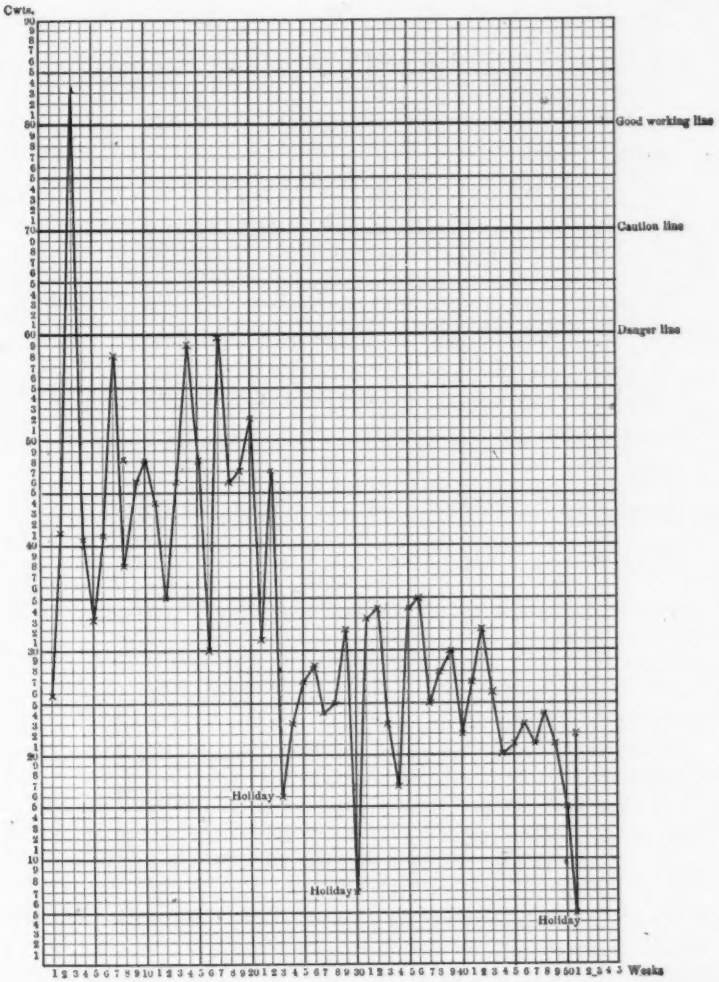


FIGURE 7. CHART OF WEEKLY OUTPUT OF A BRASS FOUNDRY WORKING BELOW THE PROFIT LINE.

ing. An example of a non-profit-producing department quite irrespective of cost of production is shown in Figure 7. This chart shows the weekly outputs of a brass foundry of which a careful estimate fixes the three guide lines at 60, 70, and 80 hundredweights per week

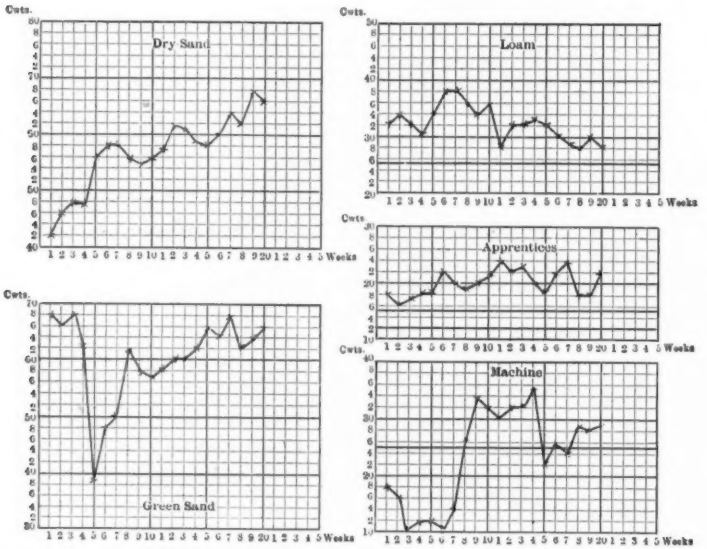


FIGURE 8. WEEKLY OUTPUT CHART SPLIT UP ACCORDING TO VARIOUS METHODS OF MOULDING.

respectively. An output of 80 hundredweights is essential to yield a business return on the capital invested.

The examples given in Figures 6 and 7 illustrate most forcibly the value of plotting outputs in the manner indicated, and though not yielding the definite information given by a system of cost factors, they nevertheless form good working guides and such as may be very readily prepared by any foundry foreman.

Figure 8 shows the weekly output of a foundry split up into the various methods of moulding by which the castings are produced. In each case guide lines are fixed and the weekly plottings very readily demonstrate the progress of the foundry. This method, being essentially a "foreman's one," will be worked to best advantage if fairly large charts are used and the co-ordinates and abscissæ so arranged as to accentuate sharply any departure from a horizontal line. The accompanying charts are all so plotted, and in this sense may be regarded as exaggerated—a pardonable fault when considering that the purpose is that of graphic representation and its chief aim to direct attention automatically to departures from normal working.

In conclusion I must state that the data included in this article are of a representative rather than an actual character.

INTENSIFIED PRODUCTION AND INDUSTRIAL INVESTMENT.

By William D. Ennis.

Mr. Ennis's central idea is that a true theory of production must comprehend every factor from the time plans for the works are undertaken till the product reaches the consumer. His article is particularly interesting in its recognition of the variables which should, and must, modify the decision upon particular items, sometimes apparently running counter to the general policy of "intensification."—THE EDITORS.

ONE indication of high industrial development is the shipping abroad of products. Tariffs may stimulate domestic sales and bring prosperity to a particular business, may even give time and opportunity for such economical equipment as will ultimately permit of export trade; but large and steady foreign consumption of a domestic manufacture can result only from such marked superiority in conditions and methods as will be of manifest effect in competition with the world. The home market is the natural market. Ocean freights and national prejudices inevitably handicap foreign trade. Only an excess of supply over demand at home, or an excess of demand over supply abroad, will justify export. The latter condition prevails, with regard to the United States, in agricultural products, and in some few lines of highly specialized machinery. The former is the condition to which the average manufacturer must look forward. Shall he then reduce output, go out of business, or enter foreign trade? In a highly "protected" industry he will do the first. In a business where results are uncertain and small, he will adopt the second course. If he is a master of his craft, able to compete with the best anywhere, he will cross the seas with his goods, seeking abroad that outlet which his own country cannot supply. In order that he may thus enter the world's market, he must be at least fairly well situated with regard to accessibility of raw materials, quality of labor, and economical methods of operation. Without all of these, his case is hopeless.

The availability of raw materials is the characteristic advantage in the United States. The quality of labor is credited with large influ-

ence on volume of output; but it is largely due to the economy of operating and managing methods, with which it will be considered, that American labor is of high efficiency per unit of cost. Large production per unit of plant or of investment is not in itself sufficient for competition in a world market. Just as in a steam plant, where too high a rate of combustion results in a loss of economy, so in manufacturing, too great an output may increase the cost per unit of output. It is the object of this paper to discuss some of the factors affecting commercially both volume and cost of production.

Seizing the Opportunity and Reaping a Loss.—Capital is quickly attracted to a profitable business. When, as has been and is now sometimes the case, industrial investments net twenty, forty, and sixty per cent. return each year, construction of new plants is undertaken without much hesitation. The architect or engineer is engaged and instructed to begin operations at once. Nothing must delay the work. Frantic efforts are made to impose impossible contracts on builders and machinery dealers. Every day lost in construction represents a loss of possible profits. The plans are rushed through without time for deliberation or investigation. Buildings are constructed of the materials nearest at hand, almost without regard to quality. Machinery is purchased from the quickest and cheapest source. Any defects are corrected by makeshifts called "temporary," but destined never to be improved. The plant begins operation. Breakdown succeeds breakdown. The time lost in the first year of production would have sufficed to design, build, and equip the mill properly. But business is good, the construction period has passed, and by hook or crook the mill is kept running as nearly as possible at its normal output. After a time, prices fall. Other plants are now running, and the sixty per cent. profits dwindle to twenty, ten, five. It is close work to show any gain at all. The hastily equipped mill, with its wasteful machinery, bad arrangement, and constant breakdowns, cannot meet competition. It loses money, and eventually goes out of business.

There is a reverse condition. Rapidity of construction must sometimes supersede considerations of economical operation. A case in point in my experience was this: a certain mill was so designed that it could be operated only at half capacity or at full capacity. The engine power was insufficient for the latter. A 250-horse-power engine running five hours each day would make the power equipment ample. A careful and conservative engineer recommended the purchase of a highly economical engine, which would have required four months to build. Instead, a high-speed engine was secured from stock, and was

running within sixteen days from the date it was ordered. The saving of three and one-half months in time caused a gain of $6,700 in reduced operating expenses. The engine installed consumed more steam than a Corliss; but the loss through excessive steam consumption of this particular engine will not aggregate $6,700 in the next twenty-three years. This was a case where a too economical engineer would have made a very bad bargain.

When opportunities for economy are perceived, they must be grasped quickly. To make the saving at once may mean a greater gain than could possibly be secured by any dilatory refinements in design or cleverness in purchasing. Whether they do mean such greater gain is the first thing to be ascertained in each case, and the decision then made between speed and refinement of installation. Where two or more improvements are proposed, and only one can be executed at a time, that which offers the largest percentage of return is the first to be made.

The Value of Money.—With every different set of capitalists, and in every different section of the country, the economist must figure on a different rate of interest as representing the money required for an investment in operating economy. This rate is determined by the value in general of the investments open to the body of capital in question. There is, however, another, sometimes a higher, rate of interest, that should properly be assumed by the engineer or manufacturer in estimating on investments toward operating economy. In every business there is a certain normal rate of return for the capital engaged. Unless that capital be, for the purpose in hand, unlimited, the return from money-saving investments must be sufficient to pay a rate of interest equivalent to that paid by the industry as a whole. For example, a railway paying six per cent. return, whose capital and credit can all be employed in extending the volume of traffic, would not be justified in investing in improved locomotives unless those locomotives would decrease operating expenses after six per cent. interest had been paid on the investment. A factory earning ten per cent. profit should not estimate the net economy of a new engine on a basis of five per cent. for interest on the initial expenditure. An improvement must first return its own depreciation charge *plus* an income on its cost equal to the rate of profit on the entire business done; anything over that is the measure of its actual commercial value.

This analysis fails to take into account one factor. "In time of peace, prepare for war." Profits in the business as a whole depend upon the state of the market and the force of competition. If the

latter be too strong, the return may shrink, may even become negative. An improvement is an investment that baffles competition and strengthens profits. A reduced rate of profit will increase the value of the formula. An improvement of little benefit when business is good may be its salvation in hard times. The man of forethought will not inevitably dismiss from consideration every project less profitable than his general enterprise, but will weigh it in view of future contingencies, looking upon it as he would upon low-interest-bearing government bonds—safe, and a last resort when more lucrative channels fail.

The Control of Fixed Charges.—This is the point at which the average manager files a disclaimer of responsibility. He considers that such expenses as interest and taxes are largely beyond his control. To a certain extent, his position is tenable, because in most cases he has had no jurisdiction over the cost of construction of his plant. No matter how economical that construction may have been, the sinking fund therefor is invariably looked upon as a handicap more or less serious. The possibilities in this respect lie in two directions: In the reduction of fixed charges as proportioned to output, and in the current treatment of and distinction between *repairs* and *improvements*.

Assuming that the actual amount of fixed annual expense has been scaled down to its lowest point, the only way of reducing the rate thereof is to increase the volume or the value of output, either absolute or in relation to the volume or value of raw materials consumed. Intensified production, refinement of output, increased yield, decreased cost of supplies—these mean greater return on the capital involved, or less capital for a given return, and result in decreasing the ratio of fixed expense to net income. How shall these conditions be attained? By uninterrupted operation, commensurate mechanical units, specialized organization, incentives to efficiency, reliable equipment, reserve installations; by expert superintendence, progressive and receptive management, study and control of the markets, intelligent purchasing; by economizing devices, utilization of by-products and wastes, improved machinery; by storage space for raw materials, wise contracts for supplies, an unrestricted field for the purchase of materials, and ample capital and credit.

A few only of these essentials call for remark. By uninterrupted operation, reference is made not to freedom from breakdowns nor to absence of protracted idleness, but to such operation as will give the greatest volume of product—whether it be ten-hour or twenty-four-hour, six-day or seven-day, nine-month or twelve-month. In a highly organized industry—such, for instance, as paper-making—the

fixed expense is so important an element of cost that it is almost essential to operate day and night. In industries involving small investment, where the principal cost is that of labor, a twenty-four-hour day is not a means of economy.

The effect of twenty-four-hour service on operating economy is not invariably beneficial. True, it keeps machines running, it leaves no idle fires in the furnaces; but it is hard on machinery, harder still on men. On some planet where the days were either twenty or thirty hours long, this last objection could be overcome; but here, three shifts of eight hours make the work too easy, and two shifts of twelve make it hard. Scheduled details, such as six to eight hours on and sixteen or eighteen off, complicate system and play havoc with the efficiency of the workmen. Inactive labor, on night duty, is a constant temptation to junketing of days and dozing by night; active labor kills the man, or is so high-priced as to handicap the owner. Sunday operation is successful according to the nature of the work. In most cases it is essentially a day for repairs. Depreciation is high on a twenty-four-hour seven-day system.

Excepting in industries rapidly developing, so that intermittent improvements are a necessity, a seasonal shutdown is a serious handicap. A smaller plant, with outgoing storage capacity, is preferable when possible, if the market for the product has periods of quiescence.

One important constructional feature is the uniform alignment of equipment, ensuring that production shall not be limited by the capacity of some one machine. The ultimate load should be about the same throughout.

There is a science for every market. The manager should aim to know as much of the conditions affecting prices of raw materials as he does of those affecting the value of his output. Given opportunity for storage, he can use this knowledge by developing the speculative side of his business, and buying when the market is right. On a large scale, his supply of stocks will give him more or less control of the raw-material market. He may even find it to his advantage at times to supply his competitors. In the same manner, his storage of outgoing goods is a basis for control of the market for his products.

The manager who is solely an engineer is an economist of operation. No charge that can be avoided will he permit against his running expense. The shrewder financier seeks to wipe out his outlays in his accounts current. The one swells his improvement account, the other his repair account. What is the proper line of demarcation? A new engine replacing one worn-out is a repair. Belting is repair. A

platform scale, a water meter, a bath room, are improvements. Whatever displaces some existing asset is a repair. Whatever adds to the equipment for volume or quality of output is an improvement.

The conservative manager will incline toward the repair account as a place for the final disposal of most of his equipment charges. Once there, they are out of existence. Estimated as improvements, they will burden the entire existence of his plant. More than this, he will anticipate large outlays by gradually charging off to repairs those items which he sees are likely to require replacing in the future.

Intensified Construction.—What is known as "mill construction," as compared with old-style carpenter-built manufacturing plants, typifies the advanced industrial methods of today as compared with the rule-of-thumb procedure of the past. The engineer has replaced the profane and unclean "boss," and sagging floors and shingle roofs have been superseded by monuments of stone and steel. With refinement of construction has come refinement of maintenance. The next step will be toward such standardized and massive equipment as to approximate a mill without a repair account.

The balance between opportunist speed of construction and philosophical economy of operation must be struck by considering the questions of reserve equipment, extension, and storage. Such apparatus as is liable to fail on short notice should be duplicated or interchangeable. Where one unit is cheaper than two of joint equivalent capacity, and early extension is probable, the larger unit should be purchased. Where space is valuable, the larger unit should be purchased even if no advantage in price exists. Storage, adapted to the commodity in question, should be provided at every incoming and outgoing channel. For extension of storage capacity, the site should be ample. Possible extension should be borne in mind in every construction. The gable ends of buildings must be exposed; trackage and transportation should be designed for future as well as for present contingencies. According to the force of probability of extension, the line shafting, piping, and handling machinery should be designed. The steam-fitter leaves plugged tees for future connections on his pipe lines. The constructor must likewise provide plugged tees at each critical point. Better design the extended mill and lop it off to the specified size, than to design the specified mill without the most ample and thorough provision for extended capacity.

Intensified production and economical operation are both warranted and limited by the degree of thoroughness of construction.

THE CHANGES OF A HALF-CENTURY IN THE MARINE-ENGINE SHOP.

By Egbert P. Watson.

Mr. Watson's review deals with what might be termed the dawn of the second cycle of the modern age of machinery. The first cycle covered the introduction of the machine to relieve manual toil; the second developed, perfected, expanded the machine to the present stage of automatic and mass production. The story of pioneer conditions always is fascinating; but perhaps the most striking point brought into clear view by Mr. Watson is the wonderful rise in the condition of the mechanic which has resulted from the growth of mechanical enginering. This should be more than sufficient answer to those who fear that the working classes, in the large, can ever suffer from the introduction of labor-saving machinery.—THE EDITORS.

FIFTY years ago the marine machine-shop was carried on very differently from the way it is now, both in the shop and counting room, yet the changes are in degree only; the machine shop of today is practically the same as in 1850, at which time I went into one to learn the trade. The changes lie chiefly in the direction of the introduction of systems, the use of measuring instruments of precision, closer refinements of measuring, and rapidity of execution; but in actual workmanship the man of fifty years ago was just as good as his modern successor. True, plane surfaces and good mechanical fits were not lacking then, but they were produced at the expense of time, with but slight aid from machine tools; moreover, with some exceptions, close workmanship was not required or desired, much greater latitude in matters of detail being admissible than now. So far as durability is concerned, there are plenty of machines running today which were made by our great-grandfathers.

Much heavy work that should have been done on a lathe—fly-wheels and heavy gears of large diameter, for example—was done by hand on the floor for want of a tool that would swing it; and there are many modern machinists who would not care to tackle a fly-wheel 25 feet in diameter, in six sections, chip and file all the rim joints and the arm joints where they enter the central hub, drill the bolt holes in the rim flanges, so that every part of the structure and every bolt would be iron and iron and the wheel run true on its shaft when completed, without the use of a single machine tool. Yet this is what our forebears had to do, and they did it—in the course of time. They understood the difficulties and the requirements of every job they un-

dertook, and had to surmount them as well as they could with the facilities at command. Gears of 4 and 5 inches pitch and 6 to 8 feet in diameter had to be chipped and filed to templets laid out by scribers and dividers, because the art of gear casting was in its infancy. The teeth were full of fins and swelled spots where the sand gave way, and would not mesh, or even run, as they came from the foundry floor. Cutting gears with a hammer and chisel was not a job for an apprentice, for if the chipper was not aware of the possibilities of error and where they lay, he would find himself in difficulties by over- or under-running his templets before he got a quarter of the way around the periphery.

Naturally, it will be said, this was an expensive method of working; but for one thing, there was no other way to do the work, and for another, the best machinists received very low wages—$1.50 per day—large numbers of fairly good men getting only $1.25, and they worked steadily from bell to bell. The amount of work a good chipper could turn out would surprise modern mechanics, both as to quality and quantity. No such work is done with the hammer and chisel now; the race have died out for want of practice; the planer has supplanted them. The planer was not then entirely unknown; there were plenty, but they were rarely used upon rough or large and heavy castings unless there was a straightaway job and a lot of metal to come off, being chiefly employed upon finished work. Small hand planers, in lieu of shapers, were also used to a considerable extent for planing gibs and keys, nuts of large size strung on mandrels, etc.

In the shop where I learned the trade there were some very large lathes of home manufacture, which would swing 8 feet on the face-plate and about 25 in the pit under it, taking shafts 40 feet long and 24 inches diameter for marine engines. They would carry very heavy cuts, and I never saw one of them stalled, however large it might be. The Novelty Iron Works had two lathes of peculiar construction that would be considered very powerful today. They would not swing more than 5 feet over the shears, but they would carry any chip the tool would stand and get away with it. They were triple-geared and the belts were round, of raw hide, and ran at a very high speed—so high that it was dangerous to attempt to shift them from one speed to another without stopping the lathe. Many foolhardy workmen hurt themselves badly by trying to do this. The same shop had the forerunner of the gigantic drill-presses of the present day. We used to call it "the giraffe," for it was 30 feet over all, from top of spindle to bed plate, and had all kinds of feeds on it. It was used

for drilling, from a one-inch hole upward, and boring small cylinders. Its great forte, or principal use, so to speak, was in boring the hubs of the huge wrought-iron cranks (weighing about four tons) for the shafts. These cranks were forged solid as to their hubs, which last were sometimes 40 inches across by 24 inches deep, and a 2-inch hole was first bored in them to take the spindle of a cutter head fastened to the main spindle of the machine; this head (exactly like a flue-hole cutter used in boiler shops) was then put on and a solid core very near the finished size cut out of the crank hub. I never timed this job, but—quoting from memory only—think it took about fifteen hours, which would not be so bad even now. All tool speeds, however, were comparatively slow in those days, for we were afraid of the steel, and had good reason, for it was very unequal in quality. American steel was still in its infancy; the discouragements attending its introduction were many, and it is wonderful, with their small capitalization, that steel makers remained in business. Slotting machines were just being generally introduced; but for anything except slugging off masses of iron they were unfavorably considered. I remember very well the first slotter that was set up in the finishing shop of the Morgan Iron Works, somewhere about 1854. Up to that time all key ways for connecting rods were cut out by drilling, chipping, and filing. This was slow and costly work, for in the large rods some of the key ways were 12 and 15 inches wide by about 1¼ to 1½ inch deep. Chipping off the segments left by the drill in the center of such key ways without marring the edges of them was a very nice piece of work, and a trying one as well; none but the best talent in the shop was intrusted with it, so it was resolved to see what a slotter could do. The first experiences were not at all satisfactory, for instead of moving in a straight line, as there was every reason to expect that it would, the tool itself dodged in and out, going far beyond the lines and evading the triangular segments in an exasperating way. Moreover, when finally the operator, after taking twice as much time as a chipper and filer would, had achieved some rough resemblance to a key way, it was found that the surfaces had been so glazed by using water on the cutting tool that a file would not touch them, and for a time the slotter was abandoned; but it had to be used, and after doing a great deal of bad work it was mastered. The same difficulties occurred with bolt cutters; the men would rather use stocks and dies wherever they could than try to cut bolts in the machines; they stripped a large proportion of the bolts until the proper way to make the dies was discovered. It seems anomalous now, in some aspects of

this detail of machine work, that trouble should be encountered in so simple a matter; but every operation in a machine shop has its right and its wrong way, and usually the latter is the first.

There was a large proportion of the work which could not be dealt with on machines, and some of it that could have been, as late as fifty years ago, was still done by hand—for example, long valve stems for double-beat poppet valves. These stems were about 36 inches long by 1½ inches diameter, and had threads on one end for, say 10 inches. The whole affair was turned up in a hand lathe, threads chased and finished, by a fat old German machinist ("Joe Winkler," to wit,) and when completed they were perfect in all respects. There were plenty of screw-cutting lathes in the shop which could have done the job in much less time, but "Old Joe" never cut a drunken thread in his life (that was ever discovered) and, considering the character of the lathe he had and the nature of the job itself, that is a great deal to say. Similarly, for a long time, small slide-valve seats, say of 144 square inches, were chipped, filed, and scraped to nature in lieu of planing them, the contention being that a man could chip and file them while the planer man was getting them ready to work on. As they would have to be scraped afterward, there was nothing gained by the use of the machine; the scraping of surfaces in those days was honest work, not pseudo scraping, or blotching with an oil-stone; *that* some enterprising person invented later.

The character of the lathe work done was, upon the whole, very good. I qualify this remark for the reason that some of it was quite poor. Very little attention was paid to either the centers of the lathes themselves, or the center holes in the job; too often these last were simply dabbed in with a center punch. It would sometimes be found that the lathe center had "bottomed" on the hole, and when the lathe man who did the work had his attention called to his delinquency he scornfully repudiated the view that the shaft could not possibly be true. There was not such a thing as a center drill, or a lathe for such work, known, and this in a shop that employed three thousand men in good times. As for mandrels, they were made out of any old piece of iron that came handy, and were thrown under a vise bench by the shop sweeper when they were in his way; the centers (so-called) in them were monstrous. Universal chucks were not in general use; all work that could not be held by the common jaw chuck was fixed in wooden chucks, these last being found very convenient for the shop sweeper to start the fire in the shop stove in winter. When universal scroll chucks were introduced the first ones usually lasted about a

week; the lathe men, finding that the work slipped in them, had a trick of getting levers about four feet long, and using a sledge on the end, with the result of putting the chuck out of business speedily.

The machine work fifty years ago was not as good as it is now, one reason being that the machines themselves were defective not only in weight and design, but in workmanship as well; another reason was that in many cases the fitter had to go over the work again in any event, so that it would be time wasted to complete the lathe work in the lathe. To be truthful, I must add that the fitting was by no means what it should have been, not so much through carelessness on the part of the men as from the lack of instruments of precision for measuring. First and last, these consisted chiefly of calipers, inside and out, and a two-foot boxwood rule. Now if this last had been a consistent member of a large family it would have been in harmony with the others; but the trouble was that it differed in minute degrees of assertion as to the length of an inch and fractions thereof, so that where different men went by various rules, all of them giving false testimony, the results were not at all surprising, and the boxwood rules fell into disrepute as guides to accuracy.

It came to pass that where a detail was bored to receive another that had to pass through it, such as a pulley for a shaft, absolute driving fits being needed, the sizes had to be taken from one or the other; no reliance could be placed upon sixteenths, or thirty-seconds; the sixty-fourth, not being visible to the naked eye, was not recognized at all. There were, in the days of which I write, some men with phenomenal delicacy and sensitiveness of touch, and it is curious to note that one of them (William Paul) was afflicted with a nervous disorder to such an extent that his hand shook like a telegraphic sounder when he used calipers; but in spite of his disability his sizes were always right. Moreover, through faulty spindles, bad centers, and other defects the work was not always round, and after a man had endeavored to fit a brass vainly, possibly for half a day, he would at the last measure the bearing upon transverse diameters, and finding it to have two sizes would go to the lathe man and make remarks which hurt his feelings and, not unfrequently, resulted in fisticuffs.

One feature of the practice of fifty years ago stands out very prominently, which was that the main reliance for good work depended chiefly upon the vise hands, the machines being subsidiary. The fitters were supposed to detect and correct faults of measurement and manipulation, and were, in a sense, sub-foremen, whose dicta settled disputes without question. They exercised their pre-

rogative, for the most part, judiciously, seldom or never bringing any personal bias into the discussion, and they relieved the foreman proper of a great deal of petty inspection.

The foreman of a large machine works was in those days a person of some importance, and did more or less posing and strutting to impress it upon some who were disposed to be too familiar. Early in the day he would begin his duties by promenading the main shop, glancing around furtively to see how many men were on hand, and what they were doing; he would nod to the principal fitters but pass Tom, Dick and Harry without recognition. Apprentices received close scrutiny, not only as to their work, but in their general walk and carriage. They needed this last very much, for most of them considered that their principal duty consisted in dodging the foreman and being as useless as possible, and they were not without some justification for their behavior. The apprentice in those days was considered a necessary evil, by no means a necessity, and if not exactly a walking gentleman as to his duties, was a peripatetic youth sent upon all sorts of errands by the men and hounded mercilessly by the foreman upon general principles. What time the apprentice was not thus engaged he spent in his own pursuits, usually surreptitious smoking in remote condensers, or the fireboxes of boilers. When detected he was punished by being put to ratchet drilling in prominent places, which is a job that permits of no loafing whatever, because the sound of it can be heard all over the shop.

As to teaching them the trade, they had but slight instruction, except what they could pick up by observation, and occasional practice upon machine tools that were useless for any purpose. They were not bound by articles, but were expected to stay until of age, say five years from their entrance, and were paid about $2.50 a week for the first two years, $3.50 the next year, and $4.50 to $5 for the last years of their time. Toward the end they were given much better opportunities and were put as helpers with good workmen, so that they could show their abilities if they had any. A "smart boy," or one who learned easily, was a favorite with all, and every boy who had finished his time was given a certificate to that effect, setting forth in more or less circumspect phrases that: "the bearer, John Doe, has worked in this establishment for several years, as apprentice and journeyman; he is a good workman and attentive to his duties. I cheerfully recommend him to all who may desire his services," and this eulogium very often made the skylarker in youth mend his ways and buckle-to in earnest.

General foundry work, both iron and brass, fifty years ago was first-class in every respect, and in the marine-engine shops, at least, the men in charge had great responsibilities. The bulk of the work was very heavy, steam cylinders from 30 to 90 inches diameter by 10 and 12 feet piston-stroke, large bed plates and condensers, etc. I do not now recall that a single one of these big castings was ever lost, or "unmachinable," to coin an apt word. The metal was homogeneous, wholly sound, and neither too hard nor too soft in temper. This refers chiefly to the steam cylinders, which were costly details if not right all over. As for bed plates, they did not matter so much; there was little or no machining on them, and I fancy they consisted largely of scrap; but the smaller parts, such as valve gearing, were all that they should have been. Sometimes, indeed, the foundry foreman might be seen looking ruefully at a casting that had a pronounced case of small-pox, but it was very seldom.

The blacksmith work was first class in all respects; there was no complaint about it in the shops from any cause. There was no steam hammer in the works, everything, including heavy welds on shafts up to 6-inches diameter, being done with sledges wielded by gigantic strikers. It was a sight to see six or eight of these men, or as many as could get a place on the job, wielding sledges weighing 25 pounds coming down with rythmic regularity in exactly the spot indicated by the smith's hammer; never missing a stroke or making a foul one, and keeping it up untiringly until "rung off" by the tap of the hammer on the anvil. For shafts of large size there was in later years another shop in which there were steam hammers, and here very heavy shafts were made out of the best scrap, fagoted up and welded together from the center. The central core, so to call it, was long enough to form a porter bar, and the scrap slabs were welded onto this like putting layers of paper about a pencil. It is asserted that while many such shafts were made not one of them ever broke or showed defects. Aside from the heavy work there were many artistic smiths, so to call them, who could do as neat a job in their line as any today. One of them once made a pair of draughtsman's compasses, having triangular legs so close to size that it required nothing but fine filing and polishing to fit it for work.

Fifty years ago the waste of stores and supplies for the shop was astonishing. No one seemed to care what became of red lead, waste, washers, oil, bolts, or even files. They were handed out indiscriminately to all comers without question. Men used to wash their hands in good lard oil, used lavishly, and the quantity of it that two or three

thousand men could get away with in a week, to say nothing of annually, must have been large; sometimes they were detected and threatened with discharge if it occurred again, and after that the men went into more secluded places, but the oil was used just the same. As to files, they were scandalously abused, and if a man spoiled a new one by putting it on a rough casting he could not get another that week unless he produced the old one. This rule was easily evaded by picking up an old file and sending an apprentice to the store room for another. The men themselves used to notice the mismanagement in the direction mentioned, and wondered that it was permitted. As I remember there was no administration of the business that could be called so. The proprietors relied upon the foremen to keep their departments in full work, a portion of their duties being supposed to be oversight and care that nothing was wasted; but the foremen had no ideas of what was right and proper in the use of supplies, because they had been brought up themselves under the same system, and saw nothing wrong. This and the waste of time strike me at this late day as really appalling. Men would openly leave their jobs for an hour sometimes, wander into a secluded part of the pattern-shop store room where no one ever came, except at rare intervals, and take a nap. Some loitered behind castings with bolts in their hands, pretending to be looking for another one if detected, and stealing time unconscionably by all sorts of tricks and devices. This occurred in not one only, but all the large shops, and seemed to be permitted as an incurable evil. Workmen of the better class deplored it, and wondered how it was possible for the employers to make any money; some of them said they could not if it were not for the bill of "extras" which was always rendered, even upon contract work.

The matter of time keeping was very crude indeed, and the workmen used to laugh at the system in vogue, regarding it as worthless, so far as knowledge of the cost of any given job was concerned; so indeed it was. A clerk came around in the morning and just before quitting time at night and asked each man how long he had worked; some gave in all day, when they had sneaked into the works over a convenient back fence in a certain part of the premises at nine o'clock, and the job executed was "shop work." This last meant anything, from lacing a big belt to waiting for a job until the foreman came around. Everything was accepted as a correct time charge, and a man might say he had worked five hours upon "Number 60" when he had possibly worked one hour; five hours were then charged by the time keeper on "Number 60," when practically no time what-

ever had been spent on it. In other words, the men kept their own time and the clerk might as well have stayed in the office, so far as the question of costs was concerned. The men were paid on Saturday night without failure in any case, and very speedily, too. They all fell into line at the watchman's gate, each class by itself, all machinists in one section, boiler makers in another, laborers, carpenters, blacksmiths, etc., in another, and each man passed through on a fast walk receiving his pay envelope as it was handed out to him with hardly a pause.

One of the most serious losses of time in the marine shops of fifty years ago was the handling of details, or heavy parts, both in and out of the shops. The facilities for this consisted of inadequate cranes in the shops, which had only a limited radius of action, and a gang of laborers for transporting work about the shops to and from machines. The laborers were of the opinion that the more time they took to do their jobs the longer they would last, and they had the velocity of an ox team, which is the slowest thing in animated nature. It required about half-a-day's notice to the foreman of the gang to insure their presence at all; meanwhile, the machine would be standing idle. A little thing like this did not seem to trouble anyone, and if the workman got restive at his enforced idleness and tried to hurry things up a little he would be told where to go in words that would not look very well if printed. For lifting large boilers in and out of ships there was the Bishop derrick on the dock, but the boilers had to be brought to it first, and when they were heavy this meant sliding them for a considerable distance along greased ways of heavy timber. There were no chain blocks then, but about 1855-58, Richard Doyle, a common laborer in the Novelty Iron Works, invented and introduced the first differential pulley hoist made in the United States. Doyle had been a schoolmaster in his native country—Ireland—and was an accomplished mathematician. Upon all other subjects he was densely ignorant, but he worked out the block and, more to humor the old man than anything else, the foreman had one made. Much to his surprise it acted as Doyle said it would, and it was the wonder of the shop for a few weeks. About the same time a similar block was invented in England by Thomas A. Weston, and its success there led to its general introduction, so that through the work of Doyle and of Weston the differential chain block has come into use all over the world.

Although metallic packing for pistons, and valve-stems as well, had been in use for some time prior to the year 1850, the hemp (oftener

jute) gasket was not wholly abandoned. The Cromwell Line steamers had engines whose pistons were packed with hemp gaskets—huge things as large as a man's forearm, driven in tightly with a sledge; in one case I was the man behind the sledge, so I am pretty sure of my premises. How long they remained I do not know, for they were not countenanced by the works that built the engines but were ordered by the superintending engineer of the steamship company. The metallic packing for valve stems consisted of a series of beveled rings put into the stuffing boxes in halves, and some of the packing was merely babbit-metal shavings as fine as excelsior; but it did not work well, speedily clamping the valve stem or leaking.

The material used for steam and hot- or cold-water joints, was, in the first instance, red-lead putty (white lead and red lead made very stiff, with sometimes iron borings mixed through it) for faced joints, these having annular grooves turned in them at intervals of an inch. They never leaked, but the pressures were very low, 25 to 40 pounds at the most. Pasteboard, made from straw paper under pressure, was used for water joints, on feed pipes, etc. This was first soaked to soften it; then a coat of red paint was given in making the joint and when screwed up it was tight; it could be easily broken if the pipes had to be taken apart for any cause. A joint which could not be taken apart, but lasted forever, was the "driven," sometimes called rust, or calked joint; this was cast-iron borings saturated with sal-ammoniac, or, in the absence of it, urine, driven by thin calking tools into or between the joint flanges, which were left one-quarter of an inch apart for this kind of work. It rusted fast and was a part of the pipes thereafter.

Not long ago I visited one of these old shops, and although it had been changed in some departments, and curtailed in extent, there was enough left to make it the old shop of my youth. But one alone, of all the apprentices of fifty years ago, remained; he has been there nearly fifty years, and is now general superintendent in charge. The others, thirty or forty more, are scattered far and wide. Some have passed away; others have filled and are now filling posts of responsibility with honor; one is now writing this memoir; but by far the greater number will never answer "here, sir," to the roll-call again. Let me say "peace to their ashes"; they were good comrades, for out of the whole number I never received anything but abiding, steadfast friendship. They acted well their part on life's stage, and "there all the honor lies."

EDITORIAL COMMENT

By the untimely death of Professor John Butler Johnson, which occurred recently under tragic circumstances, the engineering profession in America has lost one of its most useful and valued members. The story of his life has been told elsewhere in detail, and indeed his work as an educator and as an author of engineering works is well known to the readers of this Magazine. It is of his monumental work in a special field that we desire to speak in this place; of the founding and seven years' development of the Engineering Index.

Early realizing that the latest and most useful expression of the progress of engineering lay in the pages of current technical periodicals, Professor Johnson began, immediately upon his installation as Professor of Civil Engineering in Washington University, to index the chief sources of such literature, and it was through his initiative and influence that the index of current technical literature appeared in the Journal of the Association of Engineering Societies from 1884 to 1891. As he said in the introduction to the last volume of the Index, edited from the pages of this Magazine for the years 1895-1900, he was the undoubted originator of this style of indexing, in so far as it required a perusal of the article and an estimate of its value named in the descriptive note; that is, in practically all that renders such indexing of real value to the engineer and professional man.

The value and importance of the Engineering Index of the present day is realized and appreciated by many, and both by those who use it and those to whose care it is now entrusted it will always be regarded as embodying the wise purpose of its founder.

* * *

Professor Johnson's measure of the importance of the great work which he inaugurated can be given at this time with peculiar fitness. It is the man's own estimate of his own work, as he saw it from without after the lapse of years and the transfer to other hands had removed any tendency to strong bias—after distance had brought it into due perspective and proportion. This view is stated in a letter written a few months before his death, and is given in part in the following extracts, expressing his judgment of the five year volume of The Engineering Index:—

"This is indeed a great professional triumph. It is an honor not only to you, but to America and to the engineering profession. * * * I know of no greater aid to engineering progress today than the index to the world's knowledge of engineering problems. It is certainly true that such an index, without a library containing the original communications, is more valuable than a library containing all such communications without an index. * * *

"From a casual inspection of the work it would seem to my mind to be above criticism. Genius has been defined as 'the ability to take infinite pains,' and under that definition this is truly a work of genius. * * *

"I consider your use of my portrait and your complimentary reference as the highest honor that has been paid me in a professional way, and I am glad that it has been done in this particular connection. I think I am prouder

of my services to the profession in this matter than of anything else I have done, and I believe it is likely to lead to greater benefits."

* * *

THE work of the engineer is becoming so intimately connected with matters of daily life and experience that it is almost time that the daily press should realize the advisability of exhibiting some small degree of intelligence in chronicling technical matters for the information of the general reader. That some improvement in this respect is necessary is certainly apparent to the intelligent reader of even the most highly self-esteemed of the metropolitan dailies.

Thus we are gravely informed by a New York daily, in a letter published in the midst of other serious information, that the original amount of electricity in the universe was apportioned, along with other elements (?), so as to produce a harmonious action of the whole, and hence that the subsequent enormous addition of "indestructible" electricity by the humanly established dynamo is destroying the original equilibrium, with the result of creating the recent destructive storms and other manifestations! Another interesting illustration of newspaper science is seen in the announcement that a boat operated by an internal combustion motor is propelled by explosions, the oil being "fed into an iron ball heated by a kerosene torch."

Not so very long ago one of the great dailies described some blasting as being performed by the aid of "four side" (forcite?) powder, this being explained to be a new explosive which acted in four directions at once, in distinction to ordinary powder, which, we were told, acted in but one direction at a time.

Is it not almost time that room was found for some small degree of technical intelligence in the newspaper office?

MR. GOOD'S article in our August issue was severe in its charges against a certain class of British shop foremen, but the arraignment is only too well sustained by other authorities and too closely paralleled by conditions existing in certain American shops. One highly valued correspondent of the Magazine, who does not desire in this particular connection to be named, carries the matter a little further than Mr. Good by tracing the abuses to their causes, or at least pointing out the conditions under which they exist. He finds them varying with the discipline dominating the establishment. Given a conscientious and energetic principal thoroughly devoted to his business, and his staff will not include any managers or foremen who cling to their positions by mere toadyism, nor will these in turn measure any workman except by his efficiency. Where organization and discipline are lax, however, practices of bribery, cajolery, and flattery creep in. And they are especially common in works (especially small works) whose principals have some weakness or fad by playing upon which the shrewd and not over-scrupulous official may ingratiate himself. As organization progresses, however, and system takes the place of individual relation, *results* become the only test. The employer bases his opinion of his foreman not upon personal feelings, but upon an analysis of the output of his department. The foreman must apply a similar measure to his workmen. Efficiency alone fixes tenure of office.

A good deal is said of the lamentable decline of the old personal relations between master and man. It had, doubtless, its amiable features. But there is another side, and it is hopeful to find that System—like her stern-browed sister, Law—with the manner of a severe governor really offers a better freedom than was ever enjoyed before she was enthroned.

REVIEW OF THE BRITISH PRESS

Engineers in the Navy.

IN a recent issue of *Engineering* there is a letter from Mr. D. B. Morison, accompanied with editorial comments, discussing again the question of the status and efficiency of engineers in the navy, and the subject is of sufficient importance to demand additional comment in this place.

Mr. Morison examines the facts in connection with the difficulty in obtaining engineer officers for the navy in comparison with the numerous applications for similar positions in merchant steamship companies, and says that practically continuous advertisement by the Admiralty for engineer officers has for a long time past yielded such inadequate and unsatisfactory results that, unless prompt measures be taken to deal with the vital question, the efficiency of the fleet will be very seriously impaired.

That this is a mild statement of the case is evident to the most casual observer. The fleet is already undermanned, so far as engineers are concerned, both in numbers and capability. The standard has been so far lowered that its accumulative effect has appreciably diminished the homogeneity and efficiency of the entire engineering personnel.

"Warships, which were formerly in charge of officers of chief engineer rank, are now in charge of junior officers, whose increased responsibilities are not compensated for by accelerated promotion; and many ships having engines up to 4,500 indicated horse power, with Belleville and other water-tube boilers, which admittedly require highly-skilled and experienced attention, carry no commissioned engineer officer, but are in charge of an artificer engineer. The whole tendency of modern education is to raise standards in all professions, and with the immense and rapid developments in mechanical science as applied to naval warfare, the lowering of the standard of engineer officers is a highly dangerous expedient."

However this state of affairs may be regarded at the Admiralty, it must be observed with the greatest satisfaction by the enemies of the Empire, who, knowing that the national defence must always rest with the fleet, are doubtless inwardly delighted at the multiplying evidences of the disintegration which is being permitted, and even ignorantly encouraged, in high quarters.

As *Engineering* well says editorially:

"The fighting efficiency of the fleet has already been very seriously impaired, as we should soon find were fighting to be done; and not only prompt, but vigorous measures are now needed to repair the defect. The danger to the country from defective administration in regard to the engineering branch of the navy has grown year by year as engineering has become more and more the predominant factor in naval operations. Masts and sails have disappeared: the propelling of a war vessel is entirely a matter of steam, and there is hardly a feature in the economy of a war vessel the effective operation of which is not dependent on the highest skill of the engineer. This is a fact that a certain section of those who influence the administration of the navy constantly ignore. They argue that the war vessel, once designed and constructed, needs no longer the application of high engineering knowledge and ability; that it will keep itself efficient if only ordinary mechanical skill be applied to maintain its upkeep; in short, that engineers are not needed, but merely engine-drivers. How fallacious such a view is need not be here insisted upon. Even if true of times of peace—which it is not—it would be entirely false for a state of war. But foolish as such a position appears, at any rate to engineers, it largely animates the spirit of opposition which now prevents the science of engineering taking its proper place in the administration of the navy.

"There is no getting away from the fact that the Board of Admiralty do not consider high engineering attainments necessary for running a war vessel and keeping it efficient.

It is plain and indisputable that engineer officers of high professional attainments cannot, by present methods, be brought forward in sufficient number for the needs of the navy; and no steps are being taken to improve these methods. Mr. Morison's facts and figures place the question beyond dispute, whatever gloss may be put upon them by official apologists in Parliament and elsewhere. Keyham has failed; direct entry has failed; temporary appointment has failed. The strongest evidence—deficiency of numbers—show that; and the Board of Admiralty is giving additional proof in attempting to get round the difficulty by substituting handicraftsmen for properly trained and educated engineers."

For a fair and impartial presentation of both sides of the subject, reference may be had to the papers of Mr. Johnson and of Mr. McFarland, elsewhere in this issue. It is hardly possible to find two men who are better informed upon the state of affairs in the navies of Great Britain and the United States respectively than are the authors of these important papers.

That the system advocated by the Personnel Board, and adopted in the United States Navy has not yet been a pronounced success, is due to the fact that it has not yet been really carried out at all. Both the text and the spirit of the personnel bill demanded that line officers should stand watch in the engine room in the same manner as engineer officers. That, through the exercise of influence, they have been able to shirk this portion of their obvious duty does not reflect creditably upon them as officers and gentlemen, but it is solely due to such failure to carry out the clear intent of the bill that it has thus far failed of its purpose.

Time, which tries all things, will, however, make this defect clear in the end. There is no test like that of experience, and it needs only a general naval war to reveal which men have been standing honourably by their duty and which have been neglecting it.

Those nations which are most dependent upon their naval strength for their supremacy are those which must necessarily feel the pressure first, but we may rest assured that those which are wise enough to realise that the era of the fighting engineer is even now with us will have least reason to fear the outcome.

Improvements in Space Telegraphy.

THERE is probably no one branch of applied science in which progress has been more rapid than in the domain of electricity. Under these circumstances there is small wonder that there should be more or less of what Humboldt calls the "horrid wrangling about priority," or that much of the wrangling, when sifted down, should prove to be based largely upon misunderstandings, or upon the natural coincidence of results attending the simultaneous work of many able men in a common field.

It was just as natural that the experimental researches of Hertz upon magnetic waves, and of Branly and Lodge upon molecular conductivity should be followed by the work of Marconi and others, as that the experiments of Oersted and Henry should have produced the results of Morse and of Wheatstone. It is also natural that the extensive experimental work of Marconi should inspire others to examine into the possible methods of detecting and recording the impulses produced by magnetic waves in the transmission of messages through space, and all such researches should be welcomed as contributing to the advent of practical communication.

Starting with simple forms of coherer and sparking coils, Mr. Marconi has gradually extended the scope of his work until it has impressed many resources which had lain dormant in the laboratory until the arrival of a working enthusiast to give them practical application. While others have been elated with results extending over a range of a few miles, Marconi has increased the distance of communication to an extent to alarm the transatlantic cable owners and arouse general attention. Under such circumstances it is almost amusing to find that his frank announcement that he has experimented with the so-called "Royal Italian Navy Coherer" is construed in some quarters into an admission of what every one at all familiar with the subject has long ago known, namely, that Mr. Marconi's inventions are necessarily skillful practical combinations of well-known elements, for attaining hitherto undreamed of results.

An interesting communication in the *Electrical Review* from Professor Angelo Banti, gives some information concerning the origin of the Italian Navy Coherer. It appears

that experiments made by Castelli, a corporal in the Italian navy, led him to construct a coherer composed of a tube with electrodes of carbon, holding two drops of mercury separated by a short cylinder of iron. This he found to be self-decohering, and by its means he successfully received messages with a telephone. About the same time that Castelli was thus experimenting at Leghorn, Lieutenant Solari, at Spezia, constructed a similar coherer, using one electrode of carbon and one of iron, with a single drop of mercury between. These results were communicated to Mr. Marconi by Lieutenant Solari, and in consequence the latter experimented with this construction. His opinion based upon his own experiments can best be obtained from his statement in his lecture before the Royal Institution, already reviewed in these columns. He found that these mercury coherers, although very convenient for experimental work, could not be relied upon to decohere with certainty. While well adapted for use with a telephone as a receiver, the changes in resistance were found to be not sufficiently abrupt to permit a recording instrument by its means.

These devices, therefore, while interesting additions to the possible methods of receiving local messages, have but a limited application, and create only a passing interest.

The real element of progress in space telegraphy lies in the production of a receiver which shall be capable of operating a recording apparatus at a rate comparable with the working of existing submarine cables, and it does not appear that this can be practically accomplished with any form of coherer. Far more promising is the improved magnetic detector, described in Mr. Marconi's lecture, acting by the variation in hysteresis produced by the magnetic waves upon a bundle of magnetised wires under the influence of a rotating magnet.

In all this evidence of activity in the development of improvements in space telegraphy there is nothing but cause for congratulation. The world at large is far too deeply interested in the progress of means of communication with all parts of the globe to take heed of petty squabbling as to the priority of the many experimenters, these are matters which they may well be left to settle as other commercial disputes are arranged. Fortunately the fundamental principles have been so widely thrown open to the public by the researches of Hertz and his followers in the physical laboratory that there is little fear that progress may be hindered or suppressed. Doubtless the most satisfactory apparatus of to-day will be relegated to the technical museum in a brief time, and new devices will take their places only to be supplanted in turn. All this must necessarily make for progress, just as similar results have been observed in the development of other branches of applied electricity, and the outcome can well be awaited with interested satisfaction.

Coal-Cutting Machinery.

In his recent paper on coal mining methods in England and America in this magazine, Mr. Ackermann called attention to the great disparity in the use of coal cutting machinery in Great Britain as compared with the United States. This matter is emphasised in a paper recently presented before the Midland Institute of Mining, Civil, and Mechanical Engineers by Mr. W. E. Garforth, and published in the *Colliery Guardian*. Apart from any discussion as to the probable duration of the British coal fields, there is the vital question as to whether coal can in future be raised and sold at such a price as will enable the British manufacturers to compete successfully with those of other countries.

"The rapid exhaustion of the thicker seams at shallow depths—the necessity for working the thinner seams, and enquiries if such seams are unduly injured by the present methods of working the thicker and underlying seams, the tonnage lost in working, the increased percentage of small coal, the loss by barriers left for boundaries and by pillars required for the support of surface property, difficulties of scarcity of labour, especially hewers, higher wages any other matters, have already caused anxiety as to the future prosperity of the coal and other trades of Great Britain. Hence, all methods of getting or dealing with coal which seek to meet these difficulties, or by which the greatest proportion of workable coal can be raised in the best condition, at the lowest cost of production, and with the greatest safety and comfort to those em-

ployed are subjects that should be fully and often discussed by those interested in mining.

After discussing at length the nature and formation of coal seams, Mr. Garforth shows that the existing methods of working are largely empirical, and have persisted in the form of pillar and stall, or stoop and room methods, the longwall method being employed only under the most favourable conditions. With the increasing depth of workings, however, the effects of superincumbent pressure have made themselves apparent to an extent which has rendered the pillar and room system most unsatisfactory, and hence the longwall system, removing all the coal at one time, has been practically made compulsory. This has unconsciously led up to the introduction of coal cutting by machinery. The long straight coal face enables machines to be employed to the best advantage, the proportionate gain over hand working being greater also for thin seams than for thicker ones.

A most important requirement for undercutting machines is that they shall be able to compete with hand holding as regards depth of cut. The earlier cuts of 2½ to 3 feet are altogether too small and a satisfactory machine should be capable of cutting 5, 6, or even 7 feet, thus dispensing as far as possible with the use of explosives, and reducing the cost of cutting to a minimum. The height of the cut should also be 5 inches or more in dirt, so as to cause a complete vertical fracture of the coal, while at the same time providing sufficient clearance to prevent the coal from being wedged or crushed by the subsidence of the roof. The mechanical arrangements of the machine should also be such as to render it capable of easy control, and the details of operation should be such as to insure complete and clean work. With such machines the output ranges from 6 to 8 tons per man per day, one hundred and seventy thousand tons having been wrought per annum from one seam 960 feet deep and 4 feet thick.

Mr. Garforth prefers compressed air to electricity for underground work, this preference being mainly on the score of safety. At the same time there are many locations in which electric power can be safely and conveniently used, and these will doubtless be extended as improvements are made.

At the present time, in the United Kingdom, coal got by machinery bears only a small proportion to the output by hand holing. The next decade will undoubtedly mark a large increase in mechanical cutting. Coal-cutting machines made in Great Britain have now passed the experimental stage, and the opinion of a large number of workmen, based on ten years' experience with the machine, as compared with a similar experience with holing by pick, is in favour of machine holing, inasmuch as higher and more regular wages can be obtained, less arduous work is required, combined with greater safety, besides other advantages.

Boilers for the Navy.

WITH the appearance of the final report of the committee appointed by the Admiralty two years ago to examine and report upon the subject of boilers for the navy, there comes opportunity for comment upon the whole subject in the light of the information thus made public.

Notwithstanding the high reputation and wide experience of the members of the committee, the members thought it advisable to conduct extensive experimental trials and upon the results of these trials and upon the previous experience obtained from the navy and from the merchant marine, the conclusions given in the report are based.

Space will not permit of an exhaustive analysis of the entire report in this place, but in addition to the specific recommendations of the committee, some of the special features of importance may be mentioned.

In the first place the favourable expression of opinion as to water-tube boilers given in the interim report, has been confirmed by the experience since gained. In like manner the committee sees no reason to alter its expressed opinion as to the unsuitability of the Belleville boiler for use in the navy. Since this latter matter is practically the most important question before the committee the reasons for rejecting the Belleville boiler demand full publication.

"The disadvantages of the Belleville boiler, as compared with the cylindrical boiler, are as follows:

"The circulation of water is defective and uncertain, and the water gauges do not indicate the amount of water in the boiler.

These causes have led to serious accidents.

"An automatic feeding apparatus of a delicate and complicated kind is necessary, in order to make the safe working of the boiler possible.

"A great excess of pressure over that in the boiler is required in the feed pipes and pumps.

"A considerable excess of boiler pressure over the working pressure at the engines is necessary.

"The quantity of water varies at different rates of combustion, although the same level may be shown on the water gauges.

"Separators with automatic blow-out valves on the main steam pipes are required in order to provide for water thrown out of the boilers when the rate of combustion or the speed of the engines is suddenly increased.

"A constant and excessive loss of feed-water.

"The upper generator tubes are liable to fail by pitting or corrosion, and, in economiser boilers, the economiser tubes are still more liable to fail from the same cause. The trouble from this cause has diminished recently, but the liability of these parts to corrosion still exists, and must be regarded as a serious disadvantage.

"The upkeep of Belleville boilers has proved to be exceedingly costly, whereas that of cylindrical boilers is trifling, and this disproportion is likely to increase materially with the age of the boilers. On account of the necessity for more repairs, ships with Belleville boilers will be laid up more frequently and for much longer periods than similar ships with cylindrical boilers.

"The additional evaporating plant required with Belleville boilers, and their greater coal consumption on ordinary service as compared with cylindrical boilers, has hitherto nullified to a great extent the saving of weight effected by their adoption, and in considering the radius of action of ships fitted with them, no real advantage has been gained by their use."

While it is believed that many of these defects may be obviated by the use of some other type of water tube boiler, yet it does not appear that there is at present any boiler of the water-tube type which has impressed the committee as possessing sufficient advantages to be suitable for general adoption exclusively. In view of the excellent economy of the cylindrical boiler, and also taking into consideration the fact that a large percentage of coal is expended for auxiliary purposes in harbour, the committee recommends that, for the present, both cylindrical and water-tube boilers be installed in naval vessels. Battleships and large cruisers are therefore recommended to be fitted with cylindrical boilers of sufficient power to work the auxiliary machinery, and to drive the ship at her ordinary cruising speed, water-tube boilers being also supplied for emergency service, and to drive the vessel at the maximum speed which may be demanded; both systems of boilers being adapted to carry steam at 210 pounds pressure, so as to give 200 pounds at the engine.

In this way the water-tube boilers will be kept clean and perfectly efficient, and by virtue of their rapid steaming qualities they will be ready for prompt service upon demand.

This idea is by no means novel, having been adopted in the United States navy in the case of the coast defence vessel Monterey several years ago, and according to Rear-Admiral Melville, the combination of cylindrical boilers and Ward water-tube boilers proved most satisfactory in that instance. The combination system has also been used for several years in the German navy with good results.

Although favourable opinions were expressed by the committee as regards the Babcock & Wilcox, the Niclausse, the Dürr, and the Yarrow boilers, yet the fact was clearly stated that no type of boiler at present in use is as economical as the cylindrical boiler, and that the above recommendation is made for use "until a thoroughly satisfactory type of water-tube boiler is obtained."

This should certainly be a stimulus to inventors and engineers especially as the committee also gives a synopsis of the advantages which a satisfactory water-tube boiler should possess.

Thus, as compared with the cylindrical boiler, a satisfactory water-tube boiler should offer less delay in steam raising; less liability to damage if the boiler be struck by a projectile; greater ease of repair and renewal of parts; less weight for power generated, ability to carry a higher steam pres-

sure; and greater fire-grate area for the same floor area. These advantages are all to be had without the introduction of counterbalancing disadvantages. This program being indicated, it is a matter for the engineering ability of the world to meet the requirements, and solve the problem. In the meantime, the most promising types now available are to be given practical trial, in connection with cylindrical boilers, as stated above.

There is one feature in connection with the whole subject which the committee has apparently seen fit to ignore, namely the fact that the more highly organised character of the water-tube boiler, in general, demands that it should at all times be in charge of thoroughly trained engineers. This is only one phase of a subject to which reference has already been made in these columns, but it is a most emphatic confirmation of what has been advanced on this point by such competent judges as Mr. D. B. Morison, Mr. Charles M. Johnson and others. The undoubted introduction of water-tube boilers in the navy is but another step in the conversion of the war ship into a fighting machine, demanding the presence and control of skilled engineers for its efficient and successful use. There is little doubt that the small measure of success which has been attained with the Belleville boilers has been largely due to the fact that they were placed in the hands of sailors rather than engineers and no matter how completely designed any form of boiler may be, it might as well be understood now as later that the machine is but a part of the equipment, and that its appearance is invariably a notice served upon the sailor that he must step back and make way for the real fighting man of the immediate future, the fighting engineer. It is but another step in the evolution of warfare, and as Huxley said to the dogmatic opponent of evolution, we must consider, not what we would prefer, but what is true.

Engines for Generating Stations.

WITH the introduction of the dynamo-electric machine there has been an interesting evolution occurring in the design of the steam engines by which the electric generators are driven. At first the dynamos were mainly of the continuous-current type, with armatures of comparatively small diameter and high rotative speed, and after experience with belt driving from existing engines, came the now well-known form of high-speed automatic engine, these involving a much lower ratio of speed multiplication, and ultimately permitting direct connection with the dynamo armature. About the time that this form of engine was perfected, the electrical practice changed. Long-distance transmission demanded the use of higher voltages, while the perfection of the transformer and converter made alternating currents not only practicable, but often preferable. The result was the general introduction of the large generating set, consisting of a slow moving engine with an alternator of large rotor diameter, the latter itself frequently forming a portion of the fly wheel of the engine. In view of the extensive experience which has now been had with both forms of driving, some recent discussion as to the advantages or disadvantages which both possess is of interest.

In a paper recently presented before the Incorporated Municipal Electrical Association by Mr. A. A. Day, the subject of the correct type of engine for large generating stations is discussed. So far as present practice is concerned, Mr. Day is quite correct in stating that the trend of opinion is in favour of slow rotative speeds.

His preference is for a horizontal low-speed compound or triple expansion engine, with direct-coupled generator between cranks. This is practically present practice on the Continent, and in support of this view, Mr. Day presents the following points in its favour:

"The most economical engines have been built of this type, and certainly it can hold its own, if properly built, with any results obtained in electric light stations. The author has recently had occasion to inquire very closely into the question of the cost of producing power in large cotton factories such as there are in Bolton, and the figures obtained were equally a good advertisement for the horizontal type of engine which is almost universally employed, and also very useful as a guide to the price at which it is necessary for power to be supplied in order to make its use become general. Such engines are found to give an indicated horse power hour for less than 1d. with coal about

7s. per ton and this on a load having a variation of 10 per cent.

"The horizontal engine does away with the necessity for steam pipes in the engine room or rather above the engine room floor, and enables the steam pipes to be reduced to a minimum.

"The engine can be kept clean at a minimum of expense and trouble.

"The repairs to such an engine will be found to be reduced to a minimum if the valve gear be of the Corliss tripped type, which appears to frighten some engineers by its complication. The complication seems to the author to be far more apparent than real. It is no more necessary that the gear should be more complicated than in the case of an enclosed high speed engine, but it is seen in the one case and not in the other.

"The engine can be easily got at for repairs, and the same applies to the dynamo. It seems to the author that the weak point of a similar type of engine to that under discussion, but vertical instead of horizontal is that to remove the top half of the field magnet ring, or to get at anything of importance on the dynamo, necessitates the dismantling of the engine.

"The dynamo being placed between the two cranks, the shaft is not in any way cut up. We all know the difficulty that has been found to exist in making a crank shaft with built cranks strong and able to withstand the throwing off and on of the full load repeatedly, as must necessarily be the case with electrical generators for power purposes and traction.

"The bearings of such an horizontal engine can be adjusted both vertically and horizontally, so enabling the armature to be adjusted inside the field, which it is very advisable should be possible. It is, of course, of the utmost importance that the turning moment should be very even in the case of three-phase or polyphase transmission, but a good deal more has been made of this point than is necessary, as there are three-phasers running on the Continent, and running satisfactorily, with engines that have only a single crank, the percentage variation being 3 per cent. of the angular velocity, and it is not all difficult to make a two-crank engine such as has been described with a far more even turning moment.

"This proves conclusively that there can be no need for the fly-wheel of a low-speed generating set being made abnormally heavy to obtain a sufficiently even turning moment, especially if the engine is not a single crank one."

The principal advantage which can be offered for the horizontal engine as opposed to the vertical form is the better drainage of the cylinders which is practicable, and it is also urged that the working parts are more accessible in the horizontal type than in the vertical. So far as the question of space is concerned, it is maintained that a certain amount of space is required for the boilers in any case, and an engine room of equal length with the necessary boiler house will always give sufficient space for slow-speed engines.

If high speed is to be advocated, Mr. Day maintains that it should be an extreme high speed, such as is produced by the turbine.

This side of the question was well presented before the same society by Mr. S. E. Fedden, whose remarks on this subject are well worth reviewing. Mr. Fedden shows that if turbines are to be used successfully they must always be used condensing, and that they should not be of small size, 200 to 300 kilowatts being the lower limit, but under these conditions they offer many advantages. Wet steam is no impediment to the operation of the turbine, although it offers especial facility for use with highly superheated steam, owing to the absence of rubbing surfaces. Its other advantages are as follows:

"Absolutely steady nature of turning moment.

"Entire absence of cylinder lubrication, which, therefore, allows of all the condensed steam being returned to the boilers. The saving in this one item alone materially assists in the reduction of station costs.

"The time occupied in cleaning down is brought to a minimum, and is about one-sixth of that required with a reciprocating engine of similar capacity.

"The entire absence of rubbing surfaces and packed glands within the steam chamber will permit of the use of superheated steam without fear of injury. The turbine specially lends itself to the use of superheat of a high temperature, and in this respect possesses a considerable advantage over a reciprocating engine.

Exceedingly small costs for attention and repairs, and great reliability of working."

It is evident that there is much to be said on both sides of the question, and there is no doubt that local conditions must always enter largely into the choice of the type of engine to be used. The engineer is too apt to look upon such subjects from the engineering side only, and he is just beginning to learn that engineering and economical general administration are necessarily united. Economy of steam is not always economy of money, and it is the ultimate advantage which must always be kept in mind. Large power houses and slow-moving big engines mean a large original outlay, upon which interest charges must be earned. Often the high cost of a site in an otherwise desirable location makes the area occupied a limiting factor.

The question of durability of the slow speed engine is much the same as has already been discussed in connection with locomotive engines. A well built slow-speed engine will almost last forever, but that is a great deal too long. It is much better economy to make the durability of the engine no greater than its economic life, and then to scrap it for something later and better.

The whole subject is one which must always remain unsettled so long as progress is maintained, and the wise engineer will plan for the immediate present with his eye on the near future, realising that in electrical engineering especially "the world do move."

Structural Work in America.

In the course of a very interesting series of papers on structural costs recently published in the *Engineer*, the practice in tall building construction in America is set forth in a manner which shows clearly how economy is attained by keeping down the labour costs.

The framework is so designed that the metal shall be handled the least number of times in the making. Planing is generally conspicuous by its absence, rolled or sheared edges taking its place. Rivets are so disposed that power driving can be used to the best advantage. Joints are so arranged that they require the minimum of work on site, and their rivets can be readily put in by pneumatic tools. Hand work is seldom to be detected—everything is as the machine has left it; as many girders, stanchions, beams, etc., are duplicated as is possible; stanchions are throughout spaced regularly; girder riveting is made alike in like spans—plates being added or dropped off as required for strength, thus one girder web plate template will often answer throughout the building; cast iron bases, pockets, shoes, and connections, where used, are just as the fettler or the tumbling barrel has left them; holes are cored or punched according to material; everything, in fact is made most evidently for work and not for show. When first seen one is tempted to think off-hand that there seems much waste of material in places and much skimping of it in others. Brackets seem large and unwieldy, whilst cleats seem small and insufficient; girder flanges appear light, and stanchions ruggedly gigantic, or vice versa, according to the object of the building. But one has only to study things out a little to realise that all this is of set purpose. We are so used at home to providing against so many chances that are never likely to happen concurrently, that our structures have taken a character of their own, and we miss these characteristics when viewing other work. If workmanship can be saved by a slight sacrifice of material, the American carefully considers it. In no land are scientific principles better understood than in his, but he is much keener after the dollar than to sacrifice it for the sake of theory, and he will unerringly fix on the cheaper way of carrying out his principle. He keeps as far away from the smith's fire as he can, and does not enlarge his scrap heap with useless croppings and clippings, and as a direct consequence gets work made very much quicker, on the whole much cheaper, and quite as good and sound and equal to what is demanded of it as though it had been made to a Government specification and was finished all over.

It may be argued by some that this sort of thing is not compatible with good work, but there is no reason why it should not be so. In masonry structures there is no attempt made to dress the inner faces of stone which is to be backed by rubble or brickwork, and since the structural work of a modern steel skeleton building is entirely imbedded it should be made to fulfill only those demands which legitimately come upon it.

REVIEW OF THE CONTINENTAL PRESS

Hydraulic Power in France.

For several years there has been much attention directed towards the possibilities of developing the immense hydraulic power available in the numerous streams of moderate size but rapid fall descending from the Alps into the lower levels of Switzerland, Italy, and France. So far as France is concerned, an extensive report was made to the Minister of Public Works about three years ago, after an investigation of the hydraulic resources of the French Alps by engineers of the *Ponts et Chaussées*, and this report was reviewed in these columns at that time. During the interval there has been a rapid growth of hydro-electric installations both in Italy and in Switzerland, but France, with opportunities equally favourable, has made far less progress. The entire subject of hydraulic power in France, together with some discussion as to the comparative tardiness in its practical utilisation, forms the subject of an important paper, presented before the Société des Ingénieurs Civils de France by M. R. Tavernier, and published in the *Memoires* of the society, from which we make some abstracts.

The principal difficulty in determining the true amount of power available appears in the variable flow of the mountain streams.

For the winter season, when the supply from melting snow is almost cut off, the water is very low, while during the spring and early summer there are frequent floods. Thus gaugings on the Isère show a flow of 150 to 250 cubic metres per second in the high waters of summer, while during the winter months the discharge falls to a mean of 14 cubic metres, and occasionally descends to a minimum of 6 cubic metres; a fair annual average being 20 cubic metres per second. Similar figures are obtained from other streams, the conditions being entirely different from rivers at lower elevations, in which the low stages of water occur in the summer months. The natural provision against these variations is the construction of storage reservoirs, but these are naturally dependent upon the topographical configuration of the surface and are not to be constructed everywhere.

M. Tavernier examines the various estimates which have been made as to the available hydraulic power existing in the French watershed of the Alps, and considers that a conservative valuation may be taken as 3 million horse power during low water, and 5 million horse power based upon the average annual flow. Naturally all of this power is not directly available. Existing installations of less than 200 horse power are not included, and a portion, about 100,000 h. p., is already in use.

These facts have been known for several years, but nevertheless little or nothing has been done of late to develope these sources of power. In this respect a comparison with Switzerland and with Italy is instructive. Thus, the estimate made by the Italian engineers in 1884, showed that there was available about 2 million horse power. Since that time the practical utilisation of many of the streams has shown that this estimate was below the facts. Thus, in the single province of Turin there was allowed in the estimate of 1894 but 227,450 h. p., while already 100,000 h. p. is in progress of utilisation, and there is nearly 600,000 h. p. undoubtedly available. In Switzerland, also, in which the earlier estimates allowed but 582,000 h. p., the existing installations clearly show that this is far below the actual amount which can be easily utilised.

The success which has attended the development of hydro-electric plants in Italy and Switzerland, as compared with the comparatively slow progress in France, may be accounted for in several ways. In the first place Italy and Switzerland are both without coal, and hence the advantage of developing natural sources of power is more apparent. In the second place the question of the legal status of the property rights involved in the development of the hydraulic

power is not yet fully settled in France, besides which certain important sources of power are held for speculative purposes, instead of receiving immediate practical exploitation.

Apart from the mechanical details, now fairly well settled by the practice of many successful installations in various parts of the world, the main question which should determine the development of the power of the melting Alpine snows is that of cost. In this respect, as M. Tavernier points out, the use of a moderate volume of water at a high head, such as is offered in numerous places in Haute Savoie and elsewhere, possesses a great advantage over the older plants using the large volume and low head of great rivers.

This is naturally to be expected, the transmission of energy by water following the same general economic law which governs the flow of electricity, and which determines the superiority of the transmission by high voltages over conductors of small section as compared with the use of lower voltages. The great element in cost is found in the interest on the investment charges, and in the depreciation, the operative expenses forming a much smaller portion of the cost. The second element in economy results from the generation of energy in large quantities at a time, the advantage of this being well understood in all kinds of power plants.

The importance of the capital charges will be realised when it is understood that the installation cost of a hydro-electric plant may range from 100 francs per horse power to several thousand francs.

According to the figures of Blondel, the installation cost of a steam-power plant of 1,000 to 10,000 h. p. is from 250 to 300 francs per horse power, and allowing interest and depreciation at 8 per cent., and taking coal at 20 francs per ton, the cost of power is as follows:

60	francs	for 1,000	hours
140	"	" 3,000	"
240	"	" 6,000	"
300	"	" 8,000	"

The first figures correspond to the work of an electric lighting station of which the full power is required only 3 hours per day.

The second serves for a manufacturing establishment operating 10 hours per day.

The third example is that of a central power station operating for a mixed service, 20 hours per day.

The fourth represents the service of an electrochemical or metallurgical works, operating continuously with but the necessary intermission for repairs, this latter being assumed to require one month per year.

These figures show the great effect which the continuity of the service produces upon the cost of power. It is for the continuous generation of power that the hydro-electric station shows its great superiority while for intermittent and discontinuous service the steam engine will probably be able to compete successfully.

Taking 100 kilogrammetres per second of water power as required to produce a horse power on the motor shaft, the experience of existing plants shows that under favourable conditions a minimum price of 30 francs per horse power per year at the power station may be made. This price must be increased to provide for the cost of transmission, averaging probably about 100 francs per horse-power-year, but necessarily varying according to local conditions.

M. Tavernier rightly emphasises the value to France which may follow the distribution of electric power to the small manufacturers and household workers, as compared with the factory system, a feature which has already been discussed at length in these pages.

Technical Laboratories in Europe.

THE importance of the mechanical and technical laboratory as a means of scientific education has already been discussed in these pages by Professor Boulvin, but although the value of such laboratories is unquestioned, it is remarkable that France is sadly lacking in such facilities, both for education and for research. For this latter reason the report of the committee of the Conservatoire des Arts et Métiers upon the great mechanical and testing laboratories of Germany, published in the *Annales* of the Conservatoire demands interested attention, giving, as it does, the impression made by inspection upon outside and disinterested observers.

The principal object of the investigations of the commission was the acquisition of information of service in connection with

the proposed establishment of a testing laboratory in connection with the work of the Conservatoire des Arts et Métiers at Paris, and hence the comments made in the report must be received with this ultimate object kept in view.

Naturally the principal point of investigation was the Reichsanstalt at Berlin, and here the commission found much to admire, especially as no analogous institution exists in France. With this were also examined the establishments of the Aichungs-Kommission, the Versuchsanstalt, and the Maschinen-Laboratorium, in other words, the government institutions for research and standardisation at Berlin.

So far as the general research work of the Reichsanstalt is concerned, although the commission examined it with the greatest of interest, aided by the cordial co-operation of the administration, no detailed discussion was required, since its province is beyond the scope of the work of the Conservatoire des Arts et Métiers, either present or projected. The verification of standards of length and weight, also, is considered to belong rather to the Pavilion of the International Bureau at Breteuil, and hence the most important studies for the commission were found in the mechanical and electrical testing laboratories.

Naturally the work of the testing laboratory at Charlottenburg, under the efficient directorship of Professor Martens, comes most nearly to that which it is desired to establish in Paris, and a large portion of the descriptive part of the report is devoted to this institution. The work of this laboratory is so well-known that it is needless to go into a detailed account of it here. In addition to the conduct of a great number of tests by tension, compression, torsion drop, etc., as well as by the action of various tools, there have recently been carried on original researches of an important nature. These latter include investigations upon the strength of steel balls, upon the effect of oxidation upon the strength of steel wire, upon the strength of reinforced rubber tubing, etc. The laboratory has also performed valuable work in calibrating and standardising testing machines intended for use in private establishments and workshops. Much of this work has been for private parties, and the fees received have amounted to nearly as much as the operating expenses of the laboratory, although the receipts are not directly available for the administration of the laboratory, but are turned into the general treasury of the Technische Hochschule, from which the appropriations for maintenance are made.

The mechanical laboratory, founded by Professor Riedler, and now under the direction of Professor Josse, comes in for a share of commendation, and the laboratories of Dresden, Munich, Vienna, and Prague were also visited, and included in the report.

The most interesting portion of the report is that in which the recommendations are made for the establishment of a public testing laboratory in connection with the work of the Conservatoire des Arts et Métiers at Paris. It is suggested that the laboratory be divided into three sections; for the testing of materials, including metallic and non-metallic substances, and for lubricants; for testing the performance and efficiency of machines; and for physical tests, including optical tests and measurements of temperature and pressure. If possible it is considered desirable that the Bureau of Weights and Measures, now at Breteuil, should be incorporated with the latter section, or that in any case there should be a department in the proposed laboratory for the public comparison of standards of length and weight, analogous to that in operation in Berlin. This is justified by the record of the interest which the Conservatoire has always taken in metrology, from 1795, when the provisional adoption of the metric system went into effect, down to 1869, when the International Commission was created.

The report discusses the detailed arrangement of the work of the proposed laboratory at length, recommending an expenditure of 200,000 francs for equipment, and an annual appropriation of 80,000 francs for operation. The question of location, itself most important, is also considered. In the present buildings, formerly the abbey of the Benedictines, there are but limited quarters available, but at the same time it is most desirable that the laboratories shall be with in convenient access of the professors and the public. The suggestion is made in the report, that a limited amount of space for the erection of a new structure may be ob-

tained in the courtyard of the old buildings, but this plan is open to the objection that it places restriction upon future growth. It is altogether practicable, however, to place certain of the departments in the present buildings, with an annex situated at a distance, for the bulkier portion of the work, such as the testing of machines.

It is most encouraging to note this interest in the establishment of public testing laboratories in Paris, and there is certainly no institution under whose auspices such work can be more effectively conducted than the Conservatoire des Arts et Métiers. In Great Britain and in the United States bureaus of standards and physical laboratories have recently been undertaken, and the general outlook for the scientific establishment of precise and accurate data for public use is most encouraging.

Flash Boilers.

THE demands for light motive power machines for automobile service have resulted in the production of numerous devices, many of them modifications of engines already well-known but little developed, and it is interesting to notice how some of the earlier inventions, originally lacking the demand and the means for their proper development, have since been revived.

Among these may be mentioned the so-called "flash" boiler, for the rapid generation of steam without requiring the use of a large and heavy boiler full of water. In a recent issue of *Glasers Annalen* is given a review by Inspector Max Unger, of the progress and present state of perfection of the Serpollet steam automobile, practically the only steam motor vehicle which has successfully competed with the heavy gasoline and petrol machines in the speed and road trials of Europe.

As is well known, the essential feature of the Serpollet machine is the steam generator, this consisting of various arrangements of coiled tubes of small bore and thick walls, heated to a high temperature by petroleum or alcohol burners or by a coke fire. Into one end of the tube the water is injected by a suitable pump, while steam is drawn off at the other, the water being flashed into steam as it comes into contact with the heated metal. By regulating the supply of water to correspond with the demand for steam the operation may be carried on continuously without the accumulation of any water in the tube. By maintaining a high temperature and providing sufficient heating surface it has been found possible to obtain large volumes of high-pressure steam by this form of generator, and its use has been the main factor in the success of the Serpollet vehicles.

Naturally an important portion of such a generator is that which provides for the regulation of the quantity of water supplied with the volume of steam demanded, and in Herr Unger's paper is given a detailed description of the ingenious devices by which the feed pumps for the water and the liquid fuel are controlled. The engine, also, is ingeniously designed for use with high-pressure steam under the difficult conditions of road service, and the present type of Serpollet machine doubtless unites many of the advantageous points of both steam and gasoline vehicles. The engine resembles a gas engine rather more than it does a steam engine, and the method of generation, avoiding, as it does, the presence of a mass of highly heated water, while delivering what has been called "steam-gas," contributes to the resemblance.

We have thus, in the Serpollet automobile an example of the modern development of an old idea, into the history of which it may be interesting to glance.

As long ago as 1824 this idea of flashing water into steam in a highly heated tube of small section was advocated by Paul, a Swiss engineer, then in London, and it is remarkable to note that he then proposed to use his generator in a mechanically propelled vehicle.

Paul made a generator composed of a coiled tube of three-sixteenths of an inch bore and 150 feet long, and used it to furnish steam for a two horse-power engine. In the same year, 1824, the flash principle was used by an inventor named McCurdy, who employed the feature used in the Serpollet generators by making his tubes, or "chambers" as he called them, with very thick walls, this giving a high degree of strength, and at the same time enabling heat to be stored in the mass of metal to aid in the rapid generation of steam for sudden demands.

Since the time of Paul and McCurdy the

flash method of generating steam has been re-invented many times, but it has not come into practical use until the demand for a light and powerful steam generator for automobile service produced the Serpollet form. This is an excellent illustration of the manner in which a promising idea has fallen still-born when produced before the real demand for it has appeared, and before the period when the constructive methods for its application were sufficiently perfected. It has often been said that great inventions are "epoch-making," but experience has shown that certain epochs are "invention-making." The present period of automobile development has certainly done much to facilitate the production of powerful motors of light weight, and the influence of the effort which has been made in this direction cannot but develop many other applications besides those most closely before the inventors.

Waterways in Europe.

NOTWITHSTANDING the continual increase in railway communication, the superior economy of water transport renders it of increasing importance for certain classes of merchandise, and in fact each method of conveyance creates new demands for greater facilities. These facts are well emphasised by the continual discussion of plans for a system of internal waterways for central Europe and although there has been a determined opposition in certain quarters to the dislocation of commercial arrangements which some of these plans might produce, there is little doubt that ultimately the scheme in some modified form will be executed.

In an exhaustive paper by Alfred Ritter v. Weber-Ebenhof, published in a recent issue of the *Oesterreichische Wochenschrift für den Oeffentlichen Baudienst*, the whole subject of the proposed water communication in central Europe is discussed at length, together with some excellent maps of existing and proposed canals. From this paper we make some abstracts, giving a general idea of the situation.

Naturally any system of internal waterways in Europe includes the canalisation and connection of the important streams which are already the highways for important communication. Thus the watershed of central Europe includes the Rhine, Weser, Elbe, Oder, and Vistula, flowing into the North Sea, and the Po, Adige, Danube, Dneiper, and Dneister, communicating with the Adriatic, Mediterranean, and Black seas, and it requires only a rational system of canals to connect these navigable streams with each other in order to perfect a vast network of internal water communication.

After a review of existing ocean traffic, including the dimensions of important steamships and an account of existing ship canals and harbour accommodations, the present state of internal waterways in the principal countries of central Europe is examined in order to determine how they might best be united in a general international system. A portion of this work is already under construction, as, for example, the Dortmund-Ems canal, which, when completed, will connect the most important industrial centre of Germany with the Prussian port of Emshäfen. The canalisation of the Oder as far as Cosel, is also an important work, affording an outlet to the coal traffic of Silesia. The Elbe-Trave canal, completed in 1900, is another example, this enabling the commerce of the Elbe to be extended to the old Hanse town of Lübeck.

The most important canal scheme of Germany, however, is the much discussed Mittelland-Canal, or system of waterways to unite the navigation of the Rhine with the Weser and the Elbe. This scheme, which includes canalisation work on the rivers as well as the construction of new waterways, has been strongly opposed by the agrarian party and by many landholders because it is assumed to open the way for the importation of foreign grain and foodstuffs. The details of the plan, which cannot be given here, but which are detailed at length in the paper to which reference has been made, involve the expenditure of about 400 million marks. If, with this, the Danube-Moldau-Elbe canal is constructed according to the project of 1893, and also the Danube-Oder Canal, and the proposed connections with the Vistula and the Dneister, we have to add the sum of 600 million kronen (the mark and the krone being about equal to each other, and about the same value as a shilling, makes this total about £50,000,000).

The principal feature of present importance about all this work from a constructive point of view, is the necessity of adopt-

ing a standard cross section of waterway, and one which shall be sufficiently large to admit of barges of modern dimensions. A single stretch of contracted section practically limits the capacity of the entire system, and some international agreement upon this vital point is essential.

The commercial importance of a system of waterways which shall provide cheap transport between the vast grain fields of southern Russia and Hungary and the rest of Europe and her seaports can hardly be overestimated. That it would involve rearrangements in agricultural and industrial relations must be admitted, but that these would be for the general and great benefit of the interested nations cannot be denied. The railways, so far from being injured, would be the gainers, since the waterways would handle a traffic which is impossible of profitable rail transport, while the general gain and stimulus to business would add to the volume of general railway traffic. Such a system of waterways would also act to promote such close commercial and industrial relations between the nations most nearly concerned as to render the possibility of war still more remote than it is at the present time, and hasten the time when national differences will necessarily be settled upon a scientific and commercial basis.

Ejector Condensers.

WITH the increasing demand for better steam economy, especially in connection with central power plants, there has come a general desire to profit by the advantages due to the condensation of the exhaust steam, and consequent maintenance of a vacuum on the exhaust side of the piston. Many large engines are equipped with their own condensers and air pumps, the latter being connected directly with the operative parts of the engines, but in addition there have been put upon the market various combinations of independent condensers, using direct-acting water and air pumps, and these find ready sale.

A few years after the invention of the injector by Giffard, Mr. Alexander Morton, of Glasgow, conceived the idea of applying the same principle to the condensation of steam, utilising the energy of the steam and water to remove the whole of the products, including the entrained air. Although such "ejector-condensers" have found a limited application since that time, their true value has not been fully appreciated, nor has their theoretical action been fully investigated experimentally until very recently. From a paper in a recent issue of the *Revue de Mécanique*, however, by M. A. Rateau, well known for his extensive studies in all kinds of jet apparatus, we abstract some interesting information concerning this important apparatus.

Broadly described, an ejector-condenser is a device in which the exhaust steam is delivered into an annular space surrounding a vein of water. Such an ejector-condenser consists of three essential parts: the converging nozzles by which the steam and water arrive; the mixing tube, in which the steam is condensed by contact with the water; and the diverging diffuser, in which the resultant current issuing from the mixing tube has its velocity retarded and partially transformed into useful pressure.

M. Rateau proceeds to examine the mathematical theory of the ejector-condenser, showing that the principle is that of the utilisation of the head due to the velocity with which the steam and water enter the apparatus, and deduces mathematical formulas from which the sufficiency of this velocity to maintain a good vacuum is demonstrated. Even when the condensing water is delivered to the condenser without head and the discharge has no fall this velocity is more than sufficient to produce a good vacuum, but the presence of air in the steam and water, and the desirability of maintaining the steady action of the apparatus for varying discharges of steam render it preferable that a certain amount of head be furnished if possible.

Theoretically, if the head due to the velocity is greater than that supported by a vacuum, the apparatus will operate in a satisfactory manner. If, however, the engine, for any cause, discharges less than the assumed volume of exhaust steam, this velocity will be diminished. In order to provide for the regular action of the apparatus under such conditions various modifications may be employed. Thus an auxiliary jet of live steam may be used to aid in maintaining the velocity, but this is obviously wasteful, and only to be used in emergencies. Again, the cross-section of the steam

nozzle may be reduced, and the velocity correspondingly increased, but the range of regulation by this method is evidently limited. A third method, as already intimated, is to deliver the condensing water with a sufficient head to insure operation, even with but a partial supply of steam, and this may be replaced, or preferably, supplemented by providing such a fall to the discharge, in the form of a draft tube, to aid in maintaining the velocity.

M. Rateau shows that with a properly proportioned apparatus, a head of water equivalent to about 6 metres is sufficient to maintain a vacuum, even when there is no discharge of steam at all, and if it were not for the entrained air this head might be reduced to 4 metres. It is the influence of the air which modifies the action of the apparatus very materially, and this feature is investigated very thoroughly in the paper. The presence of a comparatively small proportion of air suffices to affect the vacuum very materially, and it is most desirable that sufficient head should be provided to take care of the maximum amount of entrained air.

Apart from the above considerations, the most important condition of effective operation is naturally found in the elevation of the temperature of the condensing water. It is the mixture of the steam and water which effects the condensation upon which the action of the apparatus depends. The condensation takes place with great rapidity, since, in a condenser of medium dimensions, the steam and water are in contact but about the fiftieth part of a second in the mixing tube. According to the experiments of M. Rateau, there appears to be no effect upon the elevation in temperature of the condensing water by any change in the temperature of the entering steam, the effect being produced by the volume of steam to be condensed.

The paper contains a description of a modified form of Morton condenser, devised by M. Rateau, and gives the data and results of exhaustive experimental tests which he has made, and upon which his formulas and computations are based. With a head of 6 metres upon the condensing water, there appeared to be little difficulty in maintaining a vacuum of 700 millimetres of mercury with the barometer at 760 mm., this corresponding to about 13.5 pounds per square inch.

Ejector condensers appear to be especially applicable to installations of steam turbines where the high rotative velocity renders it difficult to instal direct-connected air pumps.

In cases where there is not room for a satisfactory head of water, a good arrangement is that in which the discharge is delivered into a well which latter is drained by a centrifugal pump, such an installation being much simpler than the old type of air-pump condenser, and equally effective in maintaining a good vacuum.

The Voltaic Arc.

THERE are few phenomena more interesting than those connected with the passage of electric currents. Thus, a wire, otherwise inert, becomes heated or even fused by the heat produced by the current; again, the mere passage of a current through a wire coiled about a piece of iron renders the latter magnetic; also, the flow of a current through a wire deflects a magnetic needle in the vicinity; these and many other phenomena have formed, and will continue to form subjects for research, study and extension.

Even more interesting than the effects of the passage of currents through solid conductors are those observed when the action takes place through gaseous substances. Here the great variability of the conditions introduces phenomena so varied and curious as to render them worthy of special study. This branch of the question, the study of the voltaic arc, forms the subject of a paper by Professor Paul Janet, in a recent issue of the *Revue Generale des Sciences*, from which we make some abstracts.

At one time such a study would have been thought of interest only to the student, and physicist, but now the electric arc is an important feature in various industries, notably in the electric furnace in the production of the metallic carbides as well as of carborundum and carbon. Another, and more recent application has been found in the method of fixing atmospheric nitrogen, discussed elsewhere in this issue.

Defining the voltaic arc as the passage of an electric current through a gaseous substance at the ordinary pressure, Professor Janet reviews the various forms which have

been studied since the first production of the arc between carbon points by Sir Humphrey Davy in the year 1800. The most apparent characteristics then and since are the high temperature and the brilliant light produced, but these are so well known that the present paper proceeds at once to phenomena which have been called secondary, rather because they have been more recently observed, than for any lack of importance.

In order that the current may pass through a gas, it is necessary that the temperature should be raised sufficiently high to make it a conductor; this may be done by bringing the terminals into temporary contact, or by producing a high voltage discharge as from a Leyden jar, between the carbons, either action being to raise the temperature of the air sufficiently high to render it a conductor.

In some modern applications the solid carbons have been replaced by cores of more porous carbon, charged with certain salts, generally silicate of potassium, the result being the production of vapours which mingle with the arc, permitting it to be maintained with lower voltages than would otherwise be possible. This arrangement also permits much longer arcs to be produced, a matter of some importance in electric smelting where the material is fed through the space between the carbons.

Professor Janet examines some of the peculiarities of arcs between other terminals than those of carbon, and proceeds to discuss especially the behaviour of arcs produced by alternating currents. In the case of alternating currents, the direction of flow is reversed rapidly, generally 40 to 50 times per second, and as a consequence the arc must be extinguished and re-established as frequently. This is only possible by reason of the presence of the heated vapour, which persists long enough to re-establish the arc, and with metallic terminals it is practically impossible to maintain an arc with an alternating current. When one terminal is metallic and the other a carbon it has been found that the current passes more readily from the metal to the carbon than from the carbon to the metal, a curious property discovered in 1882 by Jamin and Maneuvrier. In consequence there is an excess of interrupted current, so to speak, passing in one direction, so that a continuous-current motor placed in the circuit will be operated, although the alternating current supplied is entirely incapable of driving it.

Among the most interesting properties of the electric arc are those which may be termed acoustic, since they relate to the production of musical and articulate sounds.

The so-called "singing arc," discovered by Mr. Duddell, is a most curious application of the theory of electric oscillations. In this apparatus there is an auxiliary circuit connecting the upper and lower carbons of an arc, there being a condenser and a resistance coil inserted in this circuit. When a proper adjustment is made between the condenser and the resistance with regard to the length of the arc, the latter is found to emit a musical note, corresponding to the period of the electric vibrations in the circuit, this varying from 1,000 to 10,000 per second. Apart from the curious effects which may thus be produced, we have in this arrangement a means of obtaining quantitative data about currents of high frequency with a precision heretofore unattainable.

These results of Mr. Duddell's are in a similar field to the interesting investigations of Dr. Simon, who has succeeded in causing the electric arc to transmit articulate sounds. This interesting experiment is based upon the variations in the arc which follow the production of sounds in its vicinity. An auxiliary circuit, similar to that employed by Mr. Duddell, but including a battery as well as a condenser, and also a microphone, can be so arranged as to reproduce in the arc articulate sounds uttered in the vicinity of the microphone. This action is explained by the minute variations in temperature produced in the gaseous envelope of the arc by the currents of the microphone. A reverse arrangement has also been devised, in which the arc is employed as a transmitter, the sounds being emitted by a telephone receiver.

Professor Janet refers to the selenium receiver, already described in these columns, by means of which the variations in the electric arc may be photographed and used in a form of cinematograph for subsequent reproduction of the sounds, and while considering these devices as possessing at present but a curious interest he believes that all these phenomena may lead to practical results of value in the approaching future.

REVIEW OF THE AMERICAN PRESS

The Fixation of Atmospheric Nitrogen.

In his Presidential address, delivered before the British Association at its Bristol meeting, several years ago, and reviewed at the time in these columns, Sir William Crookes discussed in a most interesting manner the probable duration of the world's supply of foodstuffs. At that time he realized that natural methods might ultimately become inadequate to supply the needs of the world's growing population, and showed that recourse would be had to the work of the chemist. He then said: "Before we are in the grip of actual dearth, the chemist will step in and postpone the day of famine to so distant a period that we, and our sons and grandsons may legitimately live without undue solicitude for the future." The immediate method which he then predicted for the prolongation of the agricultural vitality of the soil lay in the discovery of some method of the fixation of atmospheric nitrogen, and the consequent regeneration of the soil by an inexhaustible artificial fertiliser.

Since then the attempt has been made to extend the laboratory experiments made by Priestley, more than a hundred years ago, and the result is the work of the Atmospheric Products Company, of which a discussion is given in a recent issue of the *Electrical World and Engineer.*

The early experiments of Priestley showed that when an electric spark was discharged through air a chemical change was produced. This change included the closer union of the oxygen atoms, producing ozone, while at the same time there was caused a union of oxygen and nitrogen, forming minute amounts of nitric oxide and nitrogen peroxide.

No systematic investigation of this subject appears to have been made until 1899, when Mr. C. S. Bradley and Mr. B. R. Lovejoy took up the problem, but these two investigators undertook the application of modern electrical machinery to the question of the production of the oxides of nitrogen on a commercial scale.

Broadly, the method consists in the passage of large quantities of air through a confined space in which powerful electric arcs are maintained. A static spark is found to be not very efficient, but experiments with alternating and direct-current arcs of different voltages have demonstrated that the best results are obtained with high-voltage direct-current arcs. It has been found best to use a pressure of about 10,000 volts, and allow it to jump electrostatically through the air for a short distance, thereby establishing the arc, and then rapidly separating the contacts until the arc breaks.

In order to produce these effects on a commercial scale, Mr. Bradley has modified a large direct-current series arc machine by a rearrangement of its circuits, and has connected this with a special device for producing the arcs in the air chamber. This arc device consists of a case containing fixed projections, within which is a revolving cylinder carrying projections, approaching the fixed ones very closely. By revolving the cylinder about 500 turns a minute, more than 400,000 arcs per minute are formed, and as the air is driven through at the rate of five cubic feet per arc per hour it will be seen that the apparatus is of considerable capacity.

The air emerges charged with about 2½ per cent. of oxides of nitrogen, and by passing it through absorption towers, nitric and nitrous acids are formed, the latter being ultimately converted into nitric acid, from which saltpetre or nitrate of soda may readily be made by contact with caustic potash or caustic soda.

The commercial importance of this process naturally depends upon the operative costs, and these again are controlled by the cost of electrical energy, but admitting that the nitrates can be produced at prices at all comparable with the natural deposits, it can be seen that the process is one of great industrial importance.

Over one million tons of nitric acid are

manufactured every year by treating natural nitrates with sulphuric acid, hence this field alone is one of great magnitude. Nitrogen compounds have heretofore been produced only by utilizing the fixed nitrogen as found in combination in nature. Thus nitrogen in combination is taken from the earth in the form of Chili saltpetre and distilled with sulphuric acid. The nitric acid thus formed disappears in the arts and is made practically unrecoverable as a fixed nitrogen compound. This means that we are continually taking from the earth a most important compound which is limited in supply. Upon the fixed nitrates vegetation of all kinds depends, and several scientists, including Sir William Crookes, as above noted, have stated that very shortly nature will cease to honor these drafts upon her resources. It is estimated that twelve million tons a year of fixed nitrates will be required to bring the wheat crop of 1930 up to the amount required. It is therefore most gratifying to see that there is a prospect that we may be able to draw upon nature's reserve supply of nitrogen in the atmosphere to meet the impending deficiency.

Superheated Steam for Turbines.

We have already referred in these columns to the peculiar adaptability of the steam turbine for use with superheated steam, and now we note an interesting report of a test made of a De Laval turbine using saturated and superheated steam, showing very well the advantages of superheating.

The test, which was made by Messrs. Dean and Main, and published in a recent issue of the *Engineering Record*, was made upon a turbine of 300 brake horse power, the turbine being used in driving the new works of the De Laval Company at Trenton, N. J.

Testing a steam turbine is not practicable according to the precise lines generally adopted for reciprocating engines, and special methods must be adopted. In the first place no method of indicating being possible, it is necessary to use brake horse power in all power determinations. It is also impracticable to measure the precise amount of steam consumed except by conducting at the same time a test of boiler evaporation, or else by condensing and weighing the whole of the exhaust steam. The latter method is much to be preferred, as it gives a full account of all the steam which has passed through the engine, without the necessity for making any deductions or corrections. Unfortunately this was not practicable in the test under consideration, since a Worthington jet condenser was employed, and the condensed steam and condensing water were discharged together. The steam consumption was therefore measured by weighing the boiler feed water, and thus introducing the necessity for several corrections. In this case the comparisons of the hourly rates of evaporation in the various tests showed such a degree of uniformity that the tests possess greater value than would otherwise be considered, and in any case they afford an interesting comparative study of the operation of the same machinery under the desired conditions.

The boiler pressure was about 200 pounds per square inch, and when testing with saturated steam the entrained water was removed by a separator and deducted from the evaporation to determine the true volume of steam going to the turbine. For the superheating trials the steam was raised to about 84°F. above the temperature due to the pressure, this superheating being effected by a Babcock & Wilcox superheater used in connection with the boiler.

Since the electrical generators were connected directly with the turbine, the power developed was readily determined by measurement of the current. By a careful preliminary determination the efficiencies of the generators were measured, and corresponding corrections in the results made, while the electrical instruments were also fully tested and calibrated immediately before use.

The data and results of the tests are fully tabulated in the report and can only be given here in general. At full load, ranging from 333 to 352 brake horse power, the steam consumption for saturated steam was 15.17 pounds per horse power, while with steam superheated 84°F., the consumption was reduced to 13.94 pounds, a saving of 8.8 per cent. This is an excellent showing for the moderate degree of superheating employed, and shows that even with an engine of the moderate power used in this case a very material advantage results. With su-

perheating of 200 degrees or more, as has been successfully employed by Schmidt in a special design of reciprocating engine, the steam consumption should be brought down very close to the record for engines of the piston type.

The greatest objection which has been made to superheating has been the injurious action of high temperatures upon the working surfaces, especially by carbonizing the lubricant and inducing cutting of the cylinders and valve faces. Another difficulty has been found in the distortion of parts by unequal heating by reason of the distribution of the masses of metal. Thus, Corliss valves has been found unsuitable for use with highly superheated steam, the warping of the valve seats causing leaks and excessive wear, and lift valves have been found necessary.

With the turbine these difficulties disappear. There are no rubbing surfaces to become scored, and no lubricant to be carbonized. The wheel and nozzles are readily heated to a uniform degree by the steam, so that unequal expansion is avoided, while the absence of rubbing surfaces again renders this objection of no moment. Apparently the principal difficulty in the application of highly superheated steam to the steam turbine rests rather with the superheating device than with the motor. High superheating is hard on the superheater, and when the latter forms a portion of the boiler care must be taken that the apparatus does not become dangerous. It is not impossible that there may be a return to the independently-fired superheater, where the degree of superheat can be regulated with little difficulty, and where the possibility of interfering with the action of the boiler is eliminated. In any case the turbine offers advantages for the use of superheated steam which cannot be found in any form of reciprocating engine, and this is not the least valuable of its features.

Practical Cement Testing.

THE importance of a systematic testing of materials used in important structures has often been discussed, and we take satisfaction in calling attention to the manner in which the materials used in the new power station of the Manhattan Railway Company have been examined during the progress of its construction. From a paper by Mr. Thomas S. Clark, the resident engineer in charge of construction published in a recent issue of *Engineering News* we abstract some account of the manner in which this important work has been done.

Mr. Clark's paper relates entirely to the testing of the cement, mortar, and concrete used in the masonry and floors of this important structure. Recognizing the importance of good work in such an important building, the company has maintained a field laboratory on the site, in which all cement was tested before being used, and during the twelve months that concrete construction was being carried on, more than 3,500 briquettes were made and broken. Apart from the immediate value of the results to the company, the work forms an excellent contribution to the general knowledge of materials of construction, and as such the publication of the results is to be commended.

Apart from the immediate determination of the strength of the materials in actual use, Mr. Clark's paper brings out the following points of interest and value:

So far as the common practice of retempering cement mortar is concerned, this receives unqualified condemnation, and the records fully bear out this opinion. Rosendale cement mortar, retempered after 60 minutes, showed a reduction to one-third to one-sixth of its original tensile strength. The tests are indisputable on this point, and it is shown that the same disastrous results were obtained even when the cement was moistened every 15 minutes. Similar results were shown with Portland cements, except that a longer time was required for the injurious effect to manifest itself. While 60 minutes was sufficient to show this action for Rosendale cement it required about two hours for Portland cement to show the effect, but the safest rule is undoubtedly to allow no retempering under any circumstances.

In making tests the method of moulding the briquette is to be considered. The idea that hard packing in the mould gives the highest result is contradicted, it appearing that the hard packing diminishes the proportion of water, thus actually reducing the strength and giving irregular results. This effect appears more especially in the longer

tests, the first set being of a different nature than the ultimate process of hardening.

In regard to the strength of concrete, much emphasis is laid upon the selection of the stone. In the case of the power-house work under consideration the stone came from the excavations on the site, and by the selection of sharp clean stone, containing a minimum of mica, an excellent concrete was obtained. When the rejected stone was used in certain test cases, it appeared that the crushing strength of the concrete was only about half as great as that made with the selected stone. It is an interesting fact that when beams of concrete were tested, the modulus of rupture of cross breaking was about 1½ times greater than the strength in direct tension. The fracture in beams often showed the plane of rupture passed directly through the stones of the aggregate, so that the strength of the stone was largely a factor of the strength of the beam.

It is often the practice to demand high strength in a short time and a common rule is to specify tensile strengths for 24 hours, for 7 days, and for 28 days. These requirements can be met by the use of a sulphate, but it is found in practice that cements which show high results in short times invariably lose strength after the second month. The adulteration seems to exhilarate the first process of set, but when the second action of hardening takes place, the cement loses the strength attained at first, and settles back to the strength which it would probably have shown had the adulteration not been added.

Experiments which were made with cement briquettes with imbedded wires showed some interesting results, mainly as to the adhesion of the cement to the wires, but as these tests were made under direct tension only they are not of much practical service. The real value of metallic reinforcement in cement and concrete structures lies in the possibility of combining the tensile strength of the metal with the crushing resistance of the concrete. Tests for this purpose should be made with beams containing imbedded metal on the tension side, the proportions being so made that the elastic limit of the metal in tension should be reached at the same time as that of the concrete in compression, and any tests in which both materials are subjected to tension fails to reproduce the actual conditions of service.

Apart from the interesting results shown by Mr. Clark's paper it is interesting and gratifying to observe that in this important work the materials were tested on the ground by the engineers by whom they were to be used. It is too common a practice to specify materials by brand, by maker's name, or by nominal compliance with a previously prepared specification. If the dealers understand that all materials are to be subjected to a strict series of tests upon delivery, and that failure to meet the tests would be sufficient cause for rejection, regardless of the brand or of other considerations, the standard of materials would be maintained at a far higher point than could otherwise be possible, and it is to be hoped that this practice of rigid acceptance tests will become more general than has hitherto been the case.

Electric and Hydraulic Analogies.

In view of the fact that many phenomena in connection with electricity are somewhat difficult of comprehension to those not trained in the fundamental conceptions, there have been various attempts to devise mechanical or other analogies which shall make the relations intelligible. A very interesting paper was presented by Professor Henry T. Eddy at the Pittsburg meeting of the American Association for the Advancement of Science, setting forth the manner in which nearly all the phenomena of continuous, alternating, and variable electric currents may be shown to have corresponding hydrodynamic analogies.

The similarity between a steady flow of water in a long pipe under the action of a constant head and the behaviour of a continuous current of electricity under a constant pressure, has long been perceived, but Professor Eddy has extended the analogy much farther.

As he clearly shows, all the complicated phenomena of long-distance electric power transmission, by any combination of land lines and cables, with their sending and receiving apparatus may be completely reproduced in all its details of operation by simple pumping machinery with its transmission pipes and air chambers, whose

manner of operation may be made clear to any one without the aid of higher analysis.

Thus taking the case of a double acting pump as corresponding to an alternating generator, it may be supposed to operate a hydraulic motor of the piston type at a distance, the pressure being transmitted through pipes. Making these pipes of elastic hose, we have a set of analogies. The friction of the water in the hose corresponds to the resistance of the wires to the passage of the electric current, the inertia of the water represents inductance, and the elasticity of the hose to capacity. This relation may be pushed still further, and used to investigate other phenomena. Thus, by increasing the effect of the elasticity of the hose by the introduction of air chambers along the line a wave of pressure may be passed along the line and at the same velocity a wave current will pass, having its maximum flow at points where certain high-pressure air chambers are discharging into those next along the line. By these progressive pressure and current waves, energy will be transmitted to the motor cylinder, which need not be of the same cubic contents as that of the generator pump.

Several complete waves may be in progress of transmission along the pipe at once. The frequency of oscillation in the motor cylinder will be equal to that of the generator pump to an amount which may be completed in any given case, but it will lag in phase behind that of the force pump to an amount due to the number of waves and fractions thereof in progress of transmission along the line.

It is also easy to see how, when the second, or motor cylinder is running idle it will originate transmission waves similar to those of the original generator cylinder, but in the opposite direction. The resultant of these equal and opposite progressive waves will be a system of stationary waves along the line. We have thus analogies for practically all the phenomena of alternating electric transmission.

Similar analogies may be found for variable waves, as in telephony. Here the distortion of the waves of different pitch gives an analogy to the distortion of sound in long-distance telephone transmission.

The utility of such analogies as those suggested by Professor Eddy has been questioned, it being maintained that each series of phenomena should stand upon their own foundation, and not explained by reference to some other basis. This is doubtless correct theoretically, but at the same time it is by analogy that we obtain a great part of our knowledge, and indeed it forms the fundamental manner in which our first impressions are broadened and developed into a capacity for further extension.

The method of analogy, used with care and judgment, and not confounded with identity, may be made a valuable feature in technical training, care being taken to pass from the analogy to the fact as the grasp of the student's mind will permit. For this purpose the analogies suggested by Professor Eddy should be most useful in the preliminary training in electricity which should form a portion of every educational course of the present day, and his paper is in this respect eminently valuable.

The Essentials of Technical Education.

We have referred many times in these columns to the importance of correct methods in technical training, but the subject is one which can hardly be discussed too much.

In a valuable paper in a recent issue of the *Popular Science Monthly*, Dr. David Starr Jordan writes of university building, and although he naturally treats the subject in a general manner, yet he makes some points bearing strongly upon engineering and scientific education. After examining the functions of educational institutions which cover the ground of general culture and of professional training, Dr. Jordan proceeds to consider the crowning function of a university, that of original research.

"On this rests the advance of civilization. From the application of scientific knowledge most of the successes of the nineteenth century have arisen. It is the first era of science. Behind the application of such knowledge rests the acquisition of it. One Helmholtz, the investigator, is the parent of a thousand Edisons, the adapters of the knowledge gained by others. The great function of the German university is that of instruction through investigation. The student begins his work on a narrow space at the outer rim of knowledge. It is his duty to carry the solid ground a little farther, to

drive back ever so little it may be the darkness of ignorance and mystery. The real university is a school of research. That we possess the university spirit is our only excuse that we adopt the university name. A true university is not a collection of colleges. It is not a college with an outer fringe of professional schools. It is not a cluster of professional schools. It is the association of scholars. It is the institution from which in every direction blazes the light of original research. Its choicest product is 'that fanaticism for veracity' as Huxley calls it, that love for truth, without which man is but the toy of the elements. Its spirit is the desire 'to know things as they really are' which is the necessary attribute of 'him that overcometh.' No institution can be college, professional school and university all in one and exercise all these functions fully in the four years which form the traditional college course. To attempt it is to fail in one way or another. We do attempt it and we do fail. In the engineering courses of to-day we try to combine in four years professional training with research and culture. This can not be done, for while the professional work is reasonably complete, culture is at a minimum and research crowded to the wall. The subject of law requires three solid years for professional training alone. Three or four culture years go with this and are surely none too many. The same requirement must soon be made in engineering. We can not make an engineer in four years if we do anything else for him, and there are very many things besides engineering which go to the making of a real engineer."

It is this necessity for a greater proportion of general training which has led to the present opposition to too high a degree of specialization, concerning which reference was made last month in these columns. The engineer, of all men, should be an individual of broad general culture, since, from the very nature of his profession and because of its constantly increasing scope in all departments of life. This basic culture must largely be given before the university is entered, and here is the weak point of much of our present day training. Students come to the university before they know how to study, and much of the time is spent in acquiring that systematic habit of work which they should have brought with them.

It is true that we cannot make a man an engineer and also a man of broad general culture in four years, but this we can do.

"We can show the student the line of his professional advancement and can see him well started in its direction before he has taken his first degree. We can give in the college course something of the methods and results of advanced research. In any subject the advanced work has a higher culture value than elementary work. Thorough study of one subject is more helpful than superficial knowledge of half a dozen. To know one thing well is in Agassiz's words 'to have the backbone of culture.' By limiting the range of individual training to a few things done thoroughly it is possible to give even to the undergraduate some touch of real university method, some knowledge of how truth is won. To accomplish this is one vital part of the university's duty. It welds together the three functions of a university, and in so doing it will give the American university its most characteristic feature."

The Manufacture of Pig Iron.

IN a very interesting paper presented before the Engineer's Club of Philadelphia, and published in the *Proceedings* of the club, Mr. John Birkinbine reviewed the development of the iron manufacture in America, showing how the progress of the trade has been affected by the development of the American blast furnace.

The fact that America is a young country prevents her from having many historical associations which belong to older nations, but in the evolution of the blast furnace the whole period of development has been sufficiently recent everywhere to permit her to start on practically equal terms with European nations. Passing over the early attempts to make pig iron in New England from 1645 to 1675 Mr. Birkinbine shows that the first blast furnace in Pennsylvania, now pre-eminently the largest producer of iron, was built in 1720, and that the Cornwall furnace, built in 1740 is even yet standing.

The accounts of the old stone stack furnaces, not more than 30 feet high and 9 feet internal diameter, with their bellows, or blowing "tubs" driven by water power, seem

very primitive beside the mammoth furnaces of the beginning of the twentieth century. Charcoal fuel, and cold blast of low pressure, limited the output of these old furnaces, but with the introduction of anthracite fuel, about 1840, followed immediately by the use of coke, higher furnaces and heavier burdens became possible, and the product increased rapidly.

In 1850 the average output of anthracite furnaces was 200 tons per week, and but little progress was made in this respect until the time of the Centennial exhibition of 1876. By that time managers began to realize that a knowledge of the chemistry of furnace operation was of material advantage in practical work, and from the record of furnaces and performance which has been kept since 1873 some idea of the progress since that date may be gathered. At the present time there is made eight times as much iron from fewer furnaces than in 1873. Up to 1880 the output of a single furnace of 100 tons per day was considered phenomenal; to-day there are a number of stacks producing 400 to 500 tons per day, and from at least two furnaces 800 tons per day have been obtained on a spurt.

Apart from the improvements which have been made in the furnace proper, much has been accomplished by the auxiliary apparatus.

The early hot-blast devices, constructed of pipes, has been followed by the immense regenerative stoves, many of these being larger than the furnaces themselves of fifty years ago. Water cooled boshes form characteristic features in modern furnaces, and the importance of the water supply for this purpose will be seen when it is stated that measurements by Venturi meter show a consumption of three to four million gallons of water per day for each furnace.

Blowing engines supply more than 50,000 cubic feet of air per minute, instead of the 500 to 1,000 cubic feet of the old tubs, and air pressures of 15 to 25 pounds per square inch are now common.

Much of the progress of the Pennsylvania iron furnaces has been due to the development of enormous iron ore deposits. The old banks in various parts of the state are still worked, but probably three-fourths of the ore mined in the United States comes from the Lake Superior region, and much of it is shipped 1,200 miles to the furnaces. Although the cost of acquiring property and of stripping off the surface soil is great, the cost of mining and handling has been reduced by mechanical appliances to a stage of economy which makes this long transport commercially practicable.

The great product of these large furnaces has hastened the development of pig iron casting machines, this permitting practically continuous operation, and avoiding the old work of the sand bed, which otherwise limited production.

Naturally a factor in the development of the iron trade has been the great masses of capital available by reason of the formation of great corporations. Nevertheless Mr. Birkinbine believes there is a future for individual manufacturers.

"The iron industry has passed very largely from individual ownership to partnership and corporate control. It is now going very largely into combinations. But while an individual firm may be at a disadvantage in controlling its ore and fuel supplies and competing with larger plants, it is not intended to indicate that those who are interested in individual furnaces have little encouragement.

There are possible economies in handling large quantities, and it takes as much skill and knowledge to operate a small plant as a large one. But there is a future for a number of moderate sized blast furnaces, if, as far as practicable, labor-saving devices are used and the practice keeps abreast of the times.

Applications of Telpherage.

THE use of that form of aerial electrical transportation named telpherage by Professor Fleemin Jenkin many years ago, has been delayed by many considerations, but it is now becoming of manifest importance, and a paper by Mr. Charles M. Clark, presented before the Civil Engineers' Club of Cleveland, and published in the *Journal of the Association of Engineering Societies*, gives some interesting examples of recent practice.

The early installations were attempted before the modern development of electrical appliances, and necessarily involved the use of separate generating stations, but now,

when nearly every manufacturing establishment has its dynamo, and when electric driving is considered on every side, the introduction of one more piece of apparatus to be operated by electricity calls for little notice in that respect.

The modern telpher installation is really a small overhead trolley line, the car running either on a light rail or on a cableway, there being one or two conductors overhead through which the current is transmitted. Since no operator is carried, the car must be controlled from without, and this requirement calls for some ingenious arrangements. Thus, when it is necessary for the telpher to pass a curve or to be slowed up for any purpose, a resistance is inserted in the trolley circuit, whereby the telpher automatically reduces its speed. As soon as it reaches the other side of the curve it receives full voltage and continues its normal speed. In regular service the speeds vary from 300 to 800 feet per minute up to 20 miles per hour. The slower speeds are used when the lines are short and where there are many curves, as in manufacturing establishments, while across country the high speeds are practicable.

Mr. Clark gives a table showing the speeds and capacities of various constructions, and these reveal the great usefulness of the system. As he says, it is somewhat in the nature of a revelation to find that to carry half a ton on a level track at a speed of six miles an hour requires much less than a horse power, including all losses. As a matter of fact, the actual power consumed, at six miles per hour, for 1,000 pounds on a level, is only 0.16 horse power. This economy is partly due to the fact that the motors are attached directly to the driving wheels, and the absence of gearing gives a high efficiency as well as freedom from noise. Naturally the resistance increases rapidly with grades, and when this reaches certain limits it is found advisable to introduce gearing in order to reduce the weight of the motors.

The cost of maintenance of a telpher line can, of course only be determined after a long trial, but from present experience it must be very low. After running for a year and a half there has been no appreciable wear shown on the driving wheels, and similar wheels have stood good service for 10 years on overhead cableways.

One of the most important features of the system is its great capacity. In this respect there is no form of conveyor which shows such flexibility. Practically the same conditions apply here as on electric street railways, with the additional feature of the possession of a clear line. The capacity of the line is dependent upon two factors: first, the speed, and second, the number of telphers and trailers. The line may be originated with but one telpher and a few trailers. More telphers and trailers may be added, and if necessary coupled up in long trains. If it is desired still further to increase the capacity the line may be made double, while the carriers may be made continuous, so as to take boxes, barrels, or other freight as fast as delivered. As a practical example of the capacity of the system, it may be noted that a plant about to be installed, has a capacity of 250 tons per hour, over a distance of one-half a mile, the material to be distributed over an area of about an acre. In this respect the telpher system stands in nearly the same position for merchandise as the travelling sidewalk does for personal transportation. The closer analogy to the latter is doubtless the belt conveyor, but when operated at its maximum capacity the telpher has practically as great a capacity over much greater range.

While long-distance transmission over country was at first considered the principal field for telpherage, it is finding its most extensive applications in manufacturing establishments. In these days of consolidations of companies, factories cover immense areas, and telpher lines are available both within large buildings and also between the various structures themselves. Probably no element is more costly in manufacturing than the employment of human strength to the handling of materials. Telpherage employs machinery to do the work of men at a minimum of cost with a maximum of speed and efficiency. Modern intensified production has produced greatly increased demand for prompt handling of materials, owing to the greater output of machines and men, and it is in this field that telpherage will be found an essential auxiliary.

THE ENGINEERING INDEX

THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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Bascule.

A Trunnion Bascule Bridge. Brief illustrated description of the Clybourn Place bridge in Chicago. 500 w. R R Gaz—July 11, 1902. No. 49356.

The Grand Avenue Bascule Bridge, Milwaukee. Illustrates and describes a structure with pivoted bascules operated by electric motors. 2500 w. Eng Rec—July 12, 1902. No. 49321.

Brooklyn Bridge.

A New Plan for Improving the New York Terminal of the Brooklyn Bridge. Editorial discussing the plan of Mr. William Barclay Parsons, and reviewing the plans proposed during the last year. 2500 w. Eng News—July 10, 1902. No. 49386.

Parsons' Solution of Brooklyn Bridge Problem. Gives details of the plan proposed for the relief of the present crush, and for providing adequate facilities for transportation. Plan. 2800 w. St Ry Jour—July 12, 1902. No. 49380 D.

The Manhattan Terminal of the Brooklyn Bridge. Editorial discussion of the plan of William Barclay Parsons for the improvement of the Manhattan terminal and relief of congested traffic. 3000 w. R R Gaz—July 4, 1902. No. 49277.

Budapest.

The Schwurplatz Bridge over the Danube at Budapest (Die Schwurplatz-Do-

We supply copies of these articles. See page 975.

aubrücke in Budapest). Alois Meissner. A brief account of the progress of work on this large ornamental chain bridge, with illustrations. 400 w. Oesterr Wochenschr f d Oeffent Baudienst—June 7, 1902. No. 49431 B.

Cantilever.

The Ohio River Bridge at Marietta, Ohio. An illustrated description of a cantilever highway bridge of peculiar design about to be built. It consists of 5 spans, two separate truss spans, and three which form a cantilever, and a viaduct approach between abutments; also a graded approach to the street level. 2000 w. R R Gaz—July 11, 1902. No. 49355.

Construction.

Recent Progress in American Bridge Construction. Prof. Henry S. Jacoby. Pittsburg address before the Am. Assn. for the Adv. of Science. A review of recent construction, and the problems that have been solved. 4800 w. Sci Am Sup—July 19, 1902. No. 49575.

East River Bridge.

Making the Cables on the New East River Bridge, New York. An illustrated description of the method of building these cables which are the largest suspension cables in the world. 1600 w. Sci Am—July 26, 1902. No. 49679.

Girders.

On Permissible Unit Stresses in Railway Girders. James R. Bell. Read before the Civil & Mech. Engrs. Soc. An examination of certain unit stress sliding scales, commending one on the score of its facility of application. 1600 w. Prac Engr—July 4, 1902. Serial. 1st part. No. 49343 A.

Luxemburg.

The Luxemburg Stone Arch (Die Neue Brücke über die Petrusse in Luxemburg). An illustrated description of the greatest stone arch in the world, 275-foot span, connecting the inner city of Luxemburg with the railroad station in a suburb. 1500 w. Schweiz Bauzeitung—June 28, 1902. No. 49472 B.

Metal Bridges.

Metal Bridges (Les Ponts Métalliques). Paul Résal. A general review of the history, the present state and the future of bridges in iron and steel. 7500 w. Rev Gén des Sciences—June 15, 1902. No. 49495 D.

Moving Loads.

Experiments on Railway and Road Bridges. An account of some interesting and instructive experiments made by M. Rabut, to ascertain the results attending the transit of traffic over bridges, with respect to vibration and shock. 1200 w. Engr, Lond—July 11, 1902. No. 49372 A.

Ottawa.

The Royal Alexander Bridge at Ottawa. H. D. Bush. Illustrated description of the bridge and its construction. 4200 w. R R Gaz—July 18, 1902. No. 49610.

Removal.

Moving a Long Railroad Bridge at New Brunswick, N. J. Illustrates and describes the method of moving a 6-span, 900 ft. steel bridge 14½ ft. to one side, with a total interruption to traffic of only 15 minutes. 2000 w. Eng Rec—July 5, 1902. No. 49194.

Renewal.

An Important Bridge Renewal. Illustrated description of an important piece of bridge replacement work in progress at La Crosse, Wis., over the channels of the Mississippi and Black rivers. 1600 w. Ry Age—July 11, 1902. No. 49516.

Rolling Bridge.

The Westchester Avenue Rolling Bridge. New York. Brief illustrated description of a new bridge over the Bronx River. 1700 w. Eng Rec—July 26, 1902. No. 49640.

CANALS, RIVERS AND HARBORS.

Aqueducts.

Canal Bridge over the River Lippe. Illustrated description of one of the three masonry aqueducts carrying the Dortmund-Ems Canal over waterways. Especially describes the Eckelt, or lead-lining system which has been so successfully applied, rendering the stone work safe from all infiltration. 1500 w. Engr, Lond—July 11, 1902. No. 49545 A.

Bohemia.

The Canalization of the Moldau and Elbe in Bohemia, in 1901 (Thätigkeit der Commission für die Canalisierung des Moldau und Elbeflusses in Böhmen im Jahre 1901). Abstract of the report of the commission for improving these waterways of Austria, showing progress of the work, with illustrations. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—July 5, 1902. No. 49436 B.

The Canalization Works in Bohemia (Die Canalisierungs-Bauten in Böhmen). Johann Mrasick. A paper before the Oesterr. Ing. und Arch. Verein, giving an account of the canalization of the Moldau and Elbe Rivers, and the progress of the work. 3500 w. Zeitschr d Oesterr Ing u Arch Vereines—June 27, 1902. No. 49441 B.

Breakwater.

Haupt's Reaction Breakwater. The report of the Franklin Institute through its Committee on Sciences and the Arts, on the invention of Prof. Lewis M. Haupt. 6500 w. Jour Fr Inst—July, 1902. No. 49293 D.

We supply copies of these articles. See page 975.

Dams.

A Concrete Dam Near London, Ontario. Illustrated description of a concrete dam with flashboards and an unusual crib apron. 800 w. Eng Rec—July 26, 1902. No. 49638.

Reconstruction of the Castlewood Dam. Illustrated description of a method of reinforcing a high rock-fill dam by means of an earth embankment on its up-stream face. 500 w. Eng Rec—July 12, 1902. No. 49317.

The Tabeaud High Earth Dam, Near Jackson, Cal. An illustrated detailed description of this dam and its construction. 3000 w. Eng News—July 10, 1902. No. 49384.

Docks.

Dock Construction at Zaandam (Sluis bouw te Zaandam). J. E. Van Niftrik. A general description of the harbor improvement work at Zaandam, begun in 1901, and to be completed in 1903. 2000 w. De Ingenieur—June 28, 1902. No. 49711 D.

Ten Years of Dock Developments at Leith. An article on the port of Leith, with plan and illustrations. Principally a description of the new Imperial Dock. 2400 w. Transport—July 4, 1902. No. 49336 A.

Dredge.

Marine Bucket Dredge for Tsingtau, China (Drague Marine à Godets pour le Port de Tsingtau, Chine). A de Riva-Berni. A well illustrated description of a Smulders dredge for the harbor of Tsingtau, on Kiaochau Bay, and the floating pipe line for discharging material. 1 Plate. 1500 w. Génie Civil—June 14, 1902. No. 49480 D.

Isthmian Canals.

Comparative Characteristics of the Panama and Nicaragua Canals. From a pamphlet by Mr. Bunau-Varilla, showing the relative amount of excavation, quantity of steel, depth of cuts, cost of maintenance and operation, number of locks, etc., etc., giving diagrams. 500 w. R R Gaz—July 25, 1902. No. 49665.

The Common Sense of the Isthmian Canal Decision. An editorial summary of the successive stages of the struggle which ended in the selection of the Panama route for the Isthmian canal. 3000 w. Engineering Magazine—August, 1902. No. 49700 B.

The Panama Canal. Reviews the address of Mr. George S. Morison before the Massachusetts Reform Club, and discusses the present state of the project, and the engineering features. Ill. 3300 w. Engng—July 4, 1902. No. 49365 A.

Why Is An Isthmian Canal Not Built? Lewis M. Haupt. A discussion favoring the Nicaragua route, and urging the commencement of the work under the present administration. 3000 w. N Am Rev—July, 1902. No. 49302 D.

Japan.

River Regulation in Japan (Wildbachverbauung in Japan). Prof. Ferd. Wang. An illustrated description the forestation of hillsides and protection of the banks of brooks and rivers. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—June 7, 1902. No. 49432 B.

London.

The Port of London. Earl Egerton of Tatton. Reviews the Report of the Royal Commission on the Port of London, discussing facts given, the trade of the port, improvements needed, etc. Map. 8800 w. Nineteenth Cent—July, 1902. No. 49534 D.

Mersey.

Mersey Bar and Channels of Approach to Liverpool. Reviews the report of the Conservator of the Mersey to the Commissioners. 1200 w. Engr, Lond—July 11, 1902. No. 49546 A.

Models.

Hydraulic Experiments with Models (Ueber die Bedeutung von Modellversuchen für den Flusswasserbau). C. Krischan. A paper before the Oesterr. Ing. und Arch. Verein, giving a well-illustrated description of experiments with models of jetties and weirs, showing the superiority of curved lines over rectangular for structures for regulating streams. 5500 w. Zeitschr d Oesterr Ing u Arch Vereines—June 27, 1902. No. 49440 B.

Pribram.

The Pribram Reservoirs and the Floods of July, 1897 (Die Pribramer Werksteiche und das Juli-Hochwasser des Jahres 1897). Julius Divis. An illustrated account of damage done to dams and spillways at these Bohemian silver and lead works and mines, and the new constructions. 1 Plate. 7000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 12, 1902. No. 49437 B.

Public Works.

The River and Harbor Bill. A review of the recently published appropriations, with extracts from the Act. 2200 w. R R Gaz—July 11, 1902. No. 49359.

Reservoirs.

The Time Required to Fill Reservoirs (Die Füllzeit für Beliebig Gestaltete Sammelbecken bei Irgend Welchem Zuflusse). Prof. P. Kresnik. A graphical method for determining the time required to fill basins of any shape with any flow of water. 1200 w. Oesterr Zeitschr f d Oeffent Baudienst—May 31, 1902. No. 49428 B.

We supply copies of these articles. See page 975.

Waterways.

The Development of a Uniform System of Waterways for Europe (Die Ausbildung eines Einheitlichen Arterien-Systemes der Wasserstrassen Europas). Alfred Ritter v. Weber-Ebenhof. A general review of the existing waterways all over Europe, and a project for a complete system of canals and canalized rivers. Maps. 3 Plates. 25000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 21, 1902. No. 49433B.

CONSTRUCTION.

Building Construction.

The Battery Place Building, New York. Illustrated description of the steel-work and methods of carrying the face walls of a 20-story office building. 1800 w. Eng Rec—July 19, 1902. No. 49560.

Caissons.

Caisson Foundations (Fondations par Caissons à Air Comprimé). J. Grimaud. Abstract from *Les Travaux Publics* giving a well illustrated review of caisson work for foundation building. Serial. Two parts. 7000 w. Rev Technique—June 25, July 10, 1902. No. 49713 each D.

Contractors' Plant.

The Second Division of the New York Rapid Transit Railroad. Illustrated description of the construction of nearly 4 miles of road by trenching, with particular attention to methods of keeping records of the progress of work, moving water pipes and sewers, supporting elevated railway structures over the trench, and underpinning street railway tracks. 4400 w. Eng Rec—July 19, 1902. Serial. 1st part. No. 49557.

Contracts.

The Duties of Engineers in Enforcing Contracts. Albert J. Himes. A discussion of this subject. 2000 w. Eng News—July 17, 1902. No. 49605.

Fireproofing.

Resistance to Fire of Floors and Doors. Edwin O. Sachs. Considers those two forms of construction, showing what has been done, and giving report of tests. 3800 w. Ins Engng—June, 1902. No. 49081 C.

The Fire-Proofing of High Office Buildings. Peter B. Wight. Considers the effect of fire-proof materials on building design, discussing the plans, materials, and constructive methods. General discussion follows. 6600 w. Pro Engrs' Soc of W Penn—June, 1902. No. 49693 D.

Framework.

Steel Framework for High Buildings. Charles Worthington. Considers the types, loads, design, wind-bracing, foundations, etc. Ill. 2700 w. Pro Engrs' Soc of W Penn—June, 1902. No. 49691 D.

Masonry.

Notes of Experience in Masonry Construction. F. A. Mahan. A discussion on the construction work of different kinds of masonry and some of the difficulties. 1700 w. Eng News—July 17, 1902. No. 49606.

Rigidity of Masonry Construction and the Decay of Stone. Reports some recent failures in stone masonry and gives the greater part of Sir Thomas Drew's report on Truro Cathedral, which contains much valuable information. 4500 w. Stone—April, 1902. No. 49283 C.

Office Buildings.

The Designing of an Office Building. Colbert A. MacClure. A statement of the problem, some of the conditions to be met, etc., giving some mechanical features of the Keystone building, Pittsburg, Pa. Ill. 2000 w. Pro Engrs' Soc of W Penn June, 1902. No. 49602 D.

Roads.

The Permanent Improvement of Public Highways. William H. Evers. Gives general specifications and information concerning the road improvements in Cuyahoga County, Ohio, using brick paving. 4300 w. Brick—July, 1902. No. 49199.

Rust Prevention.

Protection of Iron and Steel in Car Construction, Also as Applying to Building Material. Charles Koons. Remarks on the proper cleaning before painting, the kind of paint, etc. 2000 w. St. Louis Ry Club—July 11, 1902. No. 49621.

Subways.

Telephone Tunnels and Street Railway Subways in Chicago. Information concerning the low-level telephone tunnels, and the schemes for underground railways. Ill. 1100 w. Eng News—July 17, 1902. No. 49604.

Suez Canal.

Through the Suez Canal on a Man-of-War. H. H. Byrne. An account of the project, its early history, the construction, etc. 2000 w. Sci Am—July 19, 1902. No. 49573.

Temporary Structures.

Temporary Timber Structures. Considers the principles to be observed in designing these structures, that they may bear safely the great weight often put upon them. 1700 w. Builder—June 14, 1902. No. 49217 A.

Tunnels.

The Pryor Gap Tunnel; Burlington & Missouri River R. R. F. T. Darrow. Illustrated description of the construction of this tunnel in Montana, of interest because of the simple means used in its excavation. 1300 w. Eng News—July 3, 1902. No. 49271.

We supply copies of these articles. See page 975.

The Simplon Tunnel and Its Construction. A description of this tunnel and the methods of working, correcting some of the errors which have appeared concerning this work. 1000 w. Engr. Lond—July 4, 1902. Serial. 1st part. No. 49373 A.

Underpinning.

Underpinning a Tall and Narrow Brick Building. Illustrated description of the method of underpinning a 6 x 12 ft. extension of a brick building 175 ft. high, having a heavy chimney in one corner. 1700 w. Eng Rec—July 5, 1902. No. 49195.

MATERIALS.

Cement.

Cement Works at Grays. Describes the works and the methods of manufacture. Everything, except the main shafting, is driven electrically. 1200 w. Engr, Lond—July 11 1902. No. 49547 A.

Portland Cement. Richard K. Meade. An illustrated description of methods employed in its manufacture, and types of American and foreign cement machinery. 2800 w. Mines & Min—July, 1902. No. 49303 C.

Standard Cement Specifications. R. W. Leslie. Read before the Am. Sec. of the International Assn. for Test. Materials. On the necessity of codifying requirements for Portland cement for different classes of service. 2300 w. Eng Rec—July 5, 1902. No. 49192.

The Advantages of Uniformity in Specifications for Cement and Methods of Testing. George S. Webster. Read before the Am. Sec. International Assn. for Test. Materials. A statement of the advantages and discussion of the causes of present variations in the results obtained. 2000 w. Eng Rec—June 28, 1902. No. 49150.

The Manufacture of Portland Cement with Rotary Kilns (Fabrication du Portland Artificiel par Fours Portatifs). E. Leduc. An illustrated description of Portland cement works at Haubourdin, France, installed by Smidth Davidsen, of Copenhagen. 2000 w. Rev Technique—July 10, 1902. No. 49714 D.

Cement Testing.

Cement Testing in Municipal Laboratories. R. L. Humphrey. A paper, slightly condensed, read before the Am. Soc. of the International Assn. for Testing Materials. A study of the equipment and methods in use in various laboratories. 3800 w. Eng Rec—July 12, 1902. No. 49314.

The Cement Testing Laboratory at Cornell University. Edgar B. Kay. Describes briefly the appointments and apparatus of these laboratories. Ill. 1500 w. Munic Engng—July, 1902. No. 49284 C.

The Testing of Cement. Editorial review of an article by Richard L. Humphrey, in *The Journal of the Franklin Institute*, on the Inspection and Testing of Cements. 3800 w. Builder—July 5, 1902. No. 49333 A.

Concrete.

Some Recent Experiments with Cements, Mortar and Concrete. Thomas S. Clark. An account of tests made of the material used in the construction of the Manhattan Ry. Co.'s Power Station, N. Y. 3000 w. Eng News—July 24, 1902. No. 49661.

The Permeability of Concrete Under High Water Pressures. J. B. McIntyre and A. L. True. Abstract of a graduating thesis to the Thayer School of Civil Engng. An account of experimental investigations. 1500 w. Eng News—June 26, 1902. No. 49147.

Wet, Dry, or Medium Concrete. H. W. Parkhurst. A tabular comparison of two sets of experiments and conclusions, drawn from them. Illustrations and discussion. 5500 w. Jour W Soc of Engrs—June, 1902. No. 49295 D.

Reinforced Concrete.

A New French Method of Cement Construction. Jean Schopfer. Concerning the uses to which reinforced concrete has been put in France, describing and illustrating some buildings constructed of this material. 1800 w. Arch Rec—Aug., 1902. Serial. 1st part. No. 49564 C.

Recent Structures in Concrete and Iron (Neuere Bauwerke und Bauwesen aus Beton und Eisen). Fritz v. Emperger. An illustrated account of the use of reinforced concrete construction in reservoirs, canals and all kinds of hydraulic work, at the time of the Paris Exposition of 1900. Two parts. 1 plate. 6500 w. Zeitscher d Oesterr Ing u Arch Vereines—June 13 and 20, 1902. No. 49438 each B.

Tests of Reinforced Concrete Beams. W. Kendrick Hatt. Read before the Am. Sec. International Assn. for Test. Materials. Describes the methods and records the results of tests made to determine the reliability of the theory advanced by the writer. 4800 w. Eng Rec—June 28, 1902. No. 49149.

Stone.

The Crystalline Rocks of Georgia. S. W. McCallie. An illustrated article describing the road-building material of the state. 1600 w. Stone—April, 1902. No. 49282 C.

Structural Steel.

A Single Grade of Steel for Bridges and Other Structures. Editorial discussion of the proposal to specify steel of 55,000 to 60,000 lbs. ultimate strength for all parts of bridges. 1300 w. Eng Rec—July 19, 1902. No. 49555.

We supply copies of these articles. See page 975.

The Desirability of Using a Single Grade of Steel for Bridges. Abstracts of the discussion at meeting of the Am. Soc. for Testing Materials. 3500 w. Eng News—June 26, 1902. No. 49146.

MEASUREMENT.

Instruments.

New Types of Hand Surveying Instruments. Illustrates and describes interesting adaptations of the gun-sight to portable surveying instruments. 1400 w. Engng—July 11, 1902. No. 49537 A.

Surveying.

Mine Surveying. Messrs. De Morest and Silvester. Read at meeting of the Assn. of Ontario Land Surveyors. An account of methods, and the benefit of mine plans. 3500 w. B C Min Rec—July, 1902. No. 49521 B.

Surveying in Central America. An account of the methods used in making surveys for the Isthmian Canal Commission. 2000 w. Eng Rec—July 19, 1902. No. 49559.

MUNICIPAL.

Elmira, N. Y.

The System of the Elmira Water, Light and Railroad Company. An illustrated description of the portion of this combination which is of particular interest to street railway men. 2000 w. St Ry Jour—July 5, 1902. No. 49261 D.

Fire Brigade.

The Reorganization of the Metropolitan Fire Brigade. An editorial discussion of the present state of affairs in regard to the fire protection of London, with suggestions for a remedy as given in a scheme by Edwin O. Sachs. 4000 w. Engng—July 4, 1902. No. 49368 A.

Pavements.

The Cost of Brick and Stone Block Pavements. Halbert Powers Gillette. Information and facts helpful in estimating. 2500 w. Eng News—July 24, 1902. No. 49662.

Sewage Disposal.

Improvements of the Mersey and Irwell Rivers, England. Explains the results attained after 10 years of government oversight of the sewage purification works in an English water-shed. 800 w. Eng Rec—July 26, 1902. No. 49639.

Sewage Purification Works at Depew, N. Y. G. Everett Hill. Illustrates and describes the system which includes a septic tank, coke primary filters or "contact beds," and stone secondary filters on the wave-bed plan. 1500 w. Eng News—June 26, 1902. No. 49145.

Sewage Purification Works at Island Park Resort, Rome City, Ind. George S. Pierson. Illustrated description of plant consisting of a septic tank, combined with purification beds. 1000 w. Eng News—July 24, 1902. No. 49663.

Washington, D. C.

Washington as a Work of Civic Art. Charles Moore. Illustrates and describes the proposed improvements for beautifying this city at a cost of many millions. 3600 w. Munic Jour & Engr—July, 1902. No. 49382 C.

WATER SUPPLY.

Filtration.

Experiments on the Purification of the Springfield Water Supply. Describes investigations to determine the practicability of filtering a supply contaminated by organisms producing offensive taste and odor. 1900 w. Eng Rec—July 12, 1902. No. 49318.

New Filter Plant at Middletown, N. Y. Illustrations with brief description. 400 w. Sci Am Sup—July 19, 1902. No. 49574.

Proposed Filtration of the Water supply of St. Louis, Mo. Statement of Edward Flad describing the proposed plan and the reasons why prompt action is desirable. 1500 w. Eng News—July 3, 1902. No. 49272.

Scrubbers for Preparing Water for Filtration. P. A. Maignen. Abstract of a paper before the Am. W. Wks. Assn. Illustrated description of a rapid filter of broken stone, with notes on results obtained with its use. 1000 w. Eng Rec—July 26, 1902. No. 49637.

Iron.

The "Rust Stains" from Water Containing Crenothrix. Describes experiments by D. D. Jackson to ascertain the cause of the precipitation of iron in water supply and methods of preventing. 1300 w. Eng Rec—July 26, 1902. No. 49636.

Large Cities.

Water Supply of Large Cities. George Y. Wisner. Discusses the methods adopted by various cities, the need of filtration, etc. 2500 w. Technic—1902. No. 40689 D.

Mains.

A Giant Force Main. Illustrated description of the new thirty-inch steel riveted force-main to carry a supply of water to Atlantic City, N. J. 1800 w. Fire & Water—July 12, 1902. No. 49381.

Seven Mysterious Breaks in a 48-Inch Pipe Line on the Boston Water Works. Frederic I. Winslow. Describes these breaks and gives the conclusions regarding the cause. 600 w. Eng News—July 3, 1902. No. 49275.

Paris.

City Water Supplies (Städtische Wasserversorgungen). Martin Paul. An il-

lustrated review of the water supply of various cities at the time of the Paris Exposition of 1900. The present article describes the Paris water supply. Serial. Part I. 5000 w. Zeitschr'd Oesterr Ing u Arch Vereines—July 4, 192. No. 49442 B.

Purification.

A Study of Self-Purification in the Sudbury River. A. G. Woodman, C. E. A. Winslow, and Paul Hansen. States the conditions of this river in Massachusetts, describes the investigations and reports results and conclusions. 3000 w. Tech Qr—June, 1902. No. 49323 E.

The Purification and Sterilization of Water. Dr. Rideal. This first lecture considers the purification by uncontrolled natural agencies, natural purification of surface waters, protection of sources, etc. 6000 w. Jour Soc of Arts—July 18, 1902. Serial. 1st Part. No. 49615 A.

Stream Pollution.

Stream Pollution Enjoined in New Jersey. Decision of New Jersey Court of Chancery forbidding a paper company to discharge waste liquids into a watercourse from which a domestic supply is drawn farther down stream. 2800 w. Eng Rec—July 12, 1902. No. 49316.

Valuations.

The Financial Questions in Water-Works Valuations. John W. Alford. Abstract of a paper before the Am. W. Wks. Assn. A discussion of the most equitable manner of ascertaining the value of a water-works plant. 4000 w. Eng Rec—July 12, 1902. No. 49315.

Water Analysis.

An Apparatus for Collecting Samples of Water at Various Depths. Earle B. Phelps. Illustrated description of an apparatus devised by the writer. 700 w. Tech Qr—June, 1902. No. 49326 E.

Water Cost.

Water Cost and Water Waste. A. L. Holmes. Read before the Mich. Engng. Soc. Discusses the great cost which is likely to increase, and also the use of meters to lessen the waste. 3000 w. Munic Engng—July, 1902. No. 49286 C.

Water-Works.

New Water-Works for Loughborough. Illustrated description of the new source of supply and the methods employed in obtaining it. 1900 w. Engr, Lond—July 11, 1902. No. 49544 A.

MISCELLANY.

Chicago.

Early Engineering in Chicago. Reminiscences by Messrs. Morehouse, L. E. Cooley. Liljencrantz, J. F. Foster and Sedden. 7500 w. Jour W Soc of Engrs—June, 1902. No. 49297 D.

Education.

The Evil of Excessive Differentiation in Engineering Courses. Edgar Marburg. Presented at meeting of the Soc. for the Promotion of Engng. Ed. Discussion limited to the bearing of the question on civil engineering. 1500 w. Eng News— July 3, 1902. No. 49273.

Madagascar.

Transportation in Madagascar (Voices de Communication et Moyens de Transport à Madagascar). F. C. Taupiat de Saint Simeux. A review of the present state and the future of the ways of communication and means of transport on the island of Madagascar. Map. 11000 w. Mem d l Soc d Ing Civils de France—May, 1902. No. 49475 G.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

An Aluminum-Sheathed Cable. Charles Bright. A short description of a cable aiming to combine strength and lightness with freedom from corrosion. 500 w. Electro-Chem & Met—May, 1902. No. 49080 A.

Conduits.

Conduits for Telephone Work. A full unabridged telephone conduit specification drawn up by A. V. Abbott. 14000 w. Elec Wld & Engr—June 21, 1902. No. 49076.

Space Telegraphy.

A Magnetic Detector of Electric Waves, Which Can Be Employed as a Receiver for Space Telegraphy. G. Marconi. Read before the Royal Soc. Describes a detector based upon the decrease of magnetic hysteresis which takes place in iron when, under certain conditions, it is exposed to the effect of high-frequency waves. 1700 w. Elect'n, Lond—July 18, 1902. No. 49619 A.

A Simple and Efficient Wireless Telegraph Receiver. A. Frederic Collins. Illustrates and describes a receiver consisting of only three parts, a coherer, an ordinary telephone receiver, and a dry cell; while supplementary to these are the vertical wire and the earthed connection. 1200 w. Sci Am—July 5, 1902. No. 40269.

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Long Distance Wireless Telegraphy and Hertzian Waves. Lee De Forest. Describes what takes place in the transmission. 600 w. Elec Wld & Engr—July 5, 1902. No. 49228.

Marconi Telegraphy. An editorial review of Mr. Marconi's recent lecture before the Royal Institution, in which he describes his new magnetic detector which replaces the coherer. Ill. 2200 w. Engng—June 20, 1902. No. 49132 A.

The Brown-Siemens-Halske System of Wireless Telegraphy. A detailed description of this system with illustrations of apparatus used. 2500 w. Sci Am Sup—July 5, 1902. No. 49270.

The "Castelli" Coherer and the "Royal Italian Navy" Coherer. Prof. Angelo Banti. An explanation called out by observations on a previous article. Considers the Castelli Coherer, Solari's experiments, and the coherer adopted by Marconi in the transatlantic transmission. 1300 w. Elec Rev, Lond—July 11, 1902. No. 40528 A.

The Castelli Receiver for Wireless Telegraphy. H. W. Sullivan. Illustrated description with discussion of its advantages and disadvantages. 900 w. Elec Rev, Lond—July 18, 1902. No. 49626 A.

The Practicability of Wireless Telegraphy. G. Marconi. From the *Fortnightly Review*. An account of the earliest paid messages transmitted, the report of yacht races, the United States Navy trials, and other proofs of practicability. 4800 w. Sci Am Sup—June 28, 1902. No. 49096.

The Progress of Space Telegraphy. G. Marconi. Lecture delivered before the Royal Institute. Describes the various problems which have recently been solved, especially the development of the writer's own work in the field. Shows it is now possible to work a number of wireless stations in vicinity of each other without interference; and describes his magnetic detector of electric waves which leaves all coherers far behind in speed, adjustment and efficiency. 8300 w. Elect'n, Lond—June 27, 1902. No. 49168 A.

Wireless Telegraphy and Submarine Cables. Emile Guarini. Briefly explains syntony and discusses multi-communication in submarine telegraphy, and in space telegraphy. Ill. 1100 w. Elec Rev, Lond—June 27, 1902. Serial. 1st part. No. 49164 A.

The Effect of Daylight Upon the Propagation of Electro-Magnetic Impulses Over Long Distances. G. Marconi. Describes results obtained in a series of tests, giving a brief description of apparatus used. 1200 w. Elect'n, Lond—July 18, 1902. No. 49620 A.

The Present and Future Status of Wireless Telephony. A. Frederick Collins. Reviews what has been accomplished in this field, discussing the uses to which it could be applied, and related matters. 1400 w. Elec Wld & Engr—June 28, 1902. No. 49109.

Wireless Telegraphy. E. Rutherford. Considers the history and development of the Marconi system. Ill. 3000 w. Can Engr—July, 1902. Serial. 1st part. No. 49210.

Telephony.

Needed Improvements in Independent Telephony. L. W. Stanton. Read before the Ind. Tel. Assn. Discusses the problems of tariff, traffic and equipment in this field. 3500 w. Elec Rev, N Y—July 12, 1902. No. 49509.

The Collins Wireless Telephone. A Frederick Collins. Briefly describes five methods by which speech may be transmitted electrically without wires, giving illustrated description of the method invented by the writer. 1500 w. Sci Am—July 19, 1902. No. 49572.

The New Telephone System in Paris. J. Bordelongue. Abstract translation from the *Journal Télégraphique*. Describes recent improvements made, eliminating the multiple jacks and making other changes that improve the service and lessen the expense. 2500 Elect'n, Lond—June 27, 1902. No. 49167 A.

The Plant of the Saratoga Telephone Company. Illustrates and describes a fine independent exchange. 1800 w. Elec Rev N Y—July 5, 1902. No. 49206.

The Telephone Service in the River Plate. Illustrates and describes recent developments in Buenos Ayres, and other important cities of the River Plate. 1400 w. Elect'n, Lond—June 27, 1902. No. 49166 A.

DISTRIBUTION.

Accumulators.

Central Station Batteries. Indicating the general causes of trouble, with these batteries, and the best method of dealing with them. 1800 w. Elec Rev, Lond—July 4, 1902. No. 49347 A.

The Use of Storage Batteries in Electric Distribution Systems. A. A. Dion. Read before the Canadian Elec Assn. A plea for the due consideration of the storage battery as a possible factor influencing the design of electrical installations, with a view to their efficient, economical and uninterrupted operation. 3300 w. Can Engr—July, 1902. No. 49209.

Alternating Currents.

The Relation of Single Phase to Multiphase Alternating Current. Fred W. Ballard. An illustrated explanation of the difference. 1800 w. Engr, U S A—June 16, 1902. No. 49074.

Alternators.

The Normal Saturation of Alternator

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Fields. R. Beattie. Defines normal saturation as that degree of saturation which makes the regulation efficiency a maximum. 600 w. Elect'n, Lond—July 11, 1902. No. 49530 A.

Fuses.

Standard Electric Safety Fuses (Ueber eine Absolute Unverwechselbarkeit an Elektrischen Schmelzsicherungen). E. Dreefs. A paper before the Verband Deutscher Elektrotechniker giving illustrated descriptions of fuses for a definite current and e. m. f., and which cannot be mistaken for fuses of a higher or lower capacity. 1000 w. Elektrotech Zeitschr—June 26, 1902. No. 49404 B.

High-Voltage Protectors.

High-Voltage Protectors (Spannungssicherungen). Dr. Gustav Benischke. A paper before the Electrotechnische Verein giving an illustrated description of apparatus for protection against high voltages below those due to lightning. 4500 w. Elektrotech Zeitschr—June 19, 1902. No. 49402 B.

Lightning Effects.

The Destruction of Cables by Lightning (Die Zerstörung von Kabelleitungen durch Blitzschlag). Karl Wilkens. A paper before the Elektrotechnischer Verein, giving an illustrated account of damage done to underground cables for heavy currents in Berlin. 2000 w. Elektrotech Zeitschr—June 26, 1902. No. 49407 B.

Phase Angle.

The Definition of the Phase Angle (Ueber die Definition der Phasenverchiebung). Dr. E. Orlich. A mathematical discussion of the proper way to designate and calculate the phase difference between current and electromotive force when the wave form differs from a sine curve. 500 w. Elektrotech Zeitschr—June 19, 1902. No. 49401 B.

Polycyclic.

The Arnold-Bragstad-la Cour Polycyclic Distribution System (Das Polycyklische Stromvertheilungssystem Arnold-Bragstad-la Cour). Prof. E. Arnold. A paper before the Elektrotechnische Gesellschaft of Frankfort-on-Main, giving an account of electrical distribution system in which currents of different voltages and frequencies are superposed on the same conducting network. Diagrams. Two parts. 5000 w. Elektrotech Zeitschr—June 25,, July 3, 1902. No. 49405 each B.

Sag of Wires.

The Proper Amount of Sag for Bare Wires of Soft Copper (Welcher Durchhang Soll Blanken Freileitungen aus Weichkupfer Gegeben Werden). K. Krohne. A discussion of the tension and sag in freely-suspended overhead wires, with diagrams, curves and tables. 1000 w. Elektrotech Zeitschr—July 3, 1902. No. 49410 B.

Stray Currents.

The Electrolysis of Gas Mains. James Swinburne. Read before the Gas Inst. (England). An impartial discussion of the subject, explaining the meaning and causes of electrolysis. 9000 w. Gas Wld —June 14 1902. No. 49065 A.

Underground.

All Wires Put Underground. Illustrates and describes the arrangements for placing underground all the wires in New Britain, Conn. 2800 w. Munic Jour & Engr—July, 1902. No. 49383 C.

ELECTRO-CHEMISTRY.

Accumulators.

Some Experiments with Zinc-Lead Accumulators (Einige Versuche mit Zink-Blei-Akkumulatoren). Oscar Gabran. An illustrated account of experiments with accumulators having lead positive plates in a case with amalgamated-copper lining, which serves as the negative plate, and zinc-sulphate electrolyte. Tables and curves. 1200 w. Elektrotech Zeitschr—June 26, 1902. No. 49406 B.

The Edison Storage Battery. Henry F. Joel. Gives brief analysis of the four patents taken out in 1900 and 1901, with detailed descriptions and claims made. Ill. 2500 w. Elec Rev, Lond—June 20, 1902. No. 49123 A.

See Electrical Engineering Distribution.

Caustic Soda.

Caustic Soda by the Diaphragm Process. Clinton Paul Townsend. Illustrated description of the electrolytic method. 800 w. Elec Wld & Engr—July 5, 1902. No. 49229.

Electrolysis.

Persulphuric Acids. Prof. H. E. Armstrong and T. Martin Lowry. Read before the Royal Soc. Reviews various experiments, reporting results. 1700 w. Elect'n, Lond—July 11, 1902. No. 49531 A.

Laboratory.

An Electrochemical Laboratory at the University of Pennsylvania. Prof. Edgar F. Smith. An illustrated description of a laboratory and installation sufficient to accommodate eighteen students. 2200 w. Electro-Chem & Met—May, 1902. No. 49070 A.

ELECTRO-PHYSICS.

Analogue.

Attenuation and Distortion on Long Distance Telephone and Power Transmission Lines Regarded as Hydrodynamic Phenomena. Henry T. Eddy. Presents

analogy between a hypothetical hydraulic system and actual electric transmission systems, extending it to the more complicated case of long-distance transmission by alternating currents. 2300 w. Elec Wld & Engr—July 26, 1902. No. 49653.

Arc.

The Voltaic Arc (L' Arc Voltaïque). P. Janet. A general discussion of the physical properties of the electric arc, with especial reference to the recent investigations of Duddell, Simon, and others. 3500 w. Rev Gen des Sciences—May 15, 1902. No. 49709 D.

Electric Discharge.

Investigations of the Electric Discharge in Rarefied Gases. W. Wien. Translated from *Annalen der Physik*. An account of experimental investigations. Ill. 3800 w. Elect'n, Lond—July 18, 1902. Serial. 1st part. No. 49622 A.

Experimental Apparatus.

An Experimental Motor and Dynamo. W. E. Parker. Illustrated description of a simple and inexpensive outfit for illustrating the principles of the electric motor and dynamo in the teaching of physics. 700 w. Sci Am—July 12, 1902. No. 49398.

Fused Quartz.

On the Fusion of Quartz in the Electric Furnace. R. S. Hutton. A report of experimental study and interesting observations made. 1300 w. Electro Chem & Met—May, 1902. No. 49078 A.

Magnetic Properties.

The Magnetic Properties of Annealed Wrought-Iron Manufactured from the Ironsand of New Zealand. Ernest Wilson. Describes the experimental investigations made, giving the results. 800 w. N Z Mines Rec—May 16, 1902. No. 49114 B.

Magnetism.

The Cyclone Theory of Magnetism. Henry E. P. Cottrell. Describes experiments of Mr. C. L. Weyher and the theories advanced by him. Ill. 2000 w. Elec Rev, Lond—June 27, 1902. Serial. 1st part. No. 49165 A.

The dissipation of Energy by Electric Currents Induced in an Iron Cylinder When Rotated in a Magnetic Field. Ernest Wilson. Read before the Royal Soc. Deals with the Energy dissipated by these electric currents, making a comparison between the results of experiment and theory. 1800 w. Elec Rev, N Y—July 26, 1902. Serial. 1st part. No. 49650.

Radio-Activity.

The Radio-Activity of Matter (La Radio-Activité de la Matière). Henri Becquerel. A lecture before the Royal Institution, London, giving a well-illustrated account of radio-active substances and phenomena. 4500 w. Rev Gén des Sciences—July 15, 1902. No. 49497 D.

GENERATING STATIONS.

Armature Reaction.

Field Distortion and Armature Reaction (Feldverzerrung und Ankerrückwirkung). R. Bauch. A paper before the Verband Deutscher Elektrotechniker, giving a general discussion of armature reaction and the distortion of field in dynamo-electric machinery, with diagrams. Serial. 2 parts. 9000 w. Elektrotech Zeitschr—July 10, 17, 1902. No. 49412 each B.

Armature Winding.

Points to Be Observed in Rewinding Coil-Wound Armatures. Illustrated directions. 3300 w. Am Elect'n—July, 1902. No. 49258.

Asynchronous Generators.

Asynchronous Generators for Single and Polyphase Currents (Asynchrone Generatoren für Ein- und Mehrphasenstrom). Alexander Heyland. A paper before the Verband Deutscher Elektrotechniker giving an illustrated description of non-synchronous alternators designed on the principle of an induction motor. Curves and diagrams. 4000 w. Elektrotech Zeitschr—June 26, 1902. No. 49403 B.

Berlin.

The Oberspree and Moabit Power Stations of Berlin, Germany. Arthur H. Allen. Illustrated detailed description of these two large stations. 5000 w. Engr, U S A—June 16, 1902. No. 49071.

Brazil.

Electricity at Manaos, Brazil. Charles J. Seibert. An illustrated description of an electric light plant; also of a railway plant operating 15 miles of single track road; and a third company which furnishes electricity for general use. 1600 w. Elec Wld & Engr—July 5, 1902. No. 49227.

Compounding.

Some Applications of Compound Alternators (Quelques Applications d'Alternateurs Compounds). M. Boucherot. A general review of the theory of compounding and a particular account of his system, in which there are compounded transformers which are connected to the alternator, to line and to the exciter which has an alternating field. A well illustrated account of practical applications and tests of this system are also given. 9000 w. Bull Soc International des Electriciens—June, 1902. No. 49492 E.

The Boucherot System of Compounding Alternators (Note sur les Alternateurs Compound, Système Boucherot). E. J. Brunswick. An illustrated description of

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this system, in which a compounded transformer supplies current to an exciter, which, in turn, excites the alternator. 3500 w. Génie Civil—July 5, 1902. No. 49487 D.

Cornell University.

A High Potential Direct-Current Plant for Experimental Work. G. S. Moler. Illustrates and describes a plant in use at Sibley College, which has proved very satisfactory. 1500 w. Elec Wld & Engr—July 19, 1902. No. 49597.

Des Moines, Iowa.

The New Power Plant of the Des Moines City Railway Co. Illustrated description of the method of rebuilding a power station without interfering with the traffic. 1700 w. Eng Rec—July 12, 1902. No. 49313.

Double-Current.

Double-Current Generators and their application. E. T. Ruthven-Murray. Calls attention to some of the uses and advantages of the special type of machine known as the double-current generator. Also discussion. 5500 w. Elec Engr, Lond—July 4, 1902. No. 49345 A.

Dynamo Design.

Inductive Reaction and Fall of Potential in Dynamo-Electric Machines (Réaction d' Induit et Chute de Tension dans les Machines Dynamo-Electriques). R. V. Picau. An attempt at a general method of predetermining the principal quantities in dynamo design, with formulae and diagrams. 5000 w. Bull Soc Internationale des Electriciens—June, 1902. No. 49491 E.

Hoboken, N. J.

The Hoboken Station of the United Electric Company. Illustrated description of a steam plant mainly noteworthy for the unusual system of piping made necessary during the reconstruction of the station in order to avoid any interference with the supply of current. 1800 w. Eng Rec—July 19, 1902. No. 47558.

Metuchen, N. J.

A Modern District Supply Central Station. Illustrated description of the plant of the Central Electric Company at Metuchen, N. J. 2700 w. Am Elect'n—July 1902. No. 49253.

Peekskill, N. Y.

New Power House of the Peekskul Lighting and Railroad Company. Illustrated description of a small modern equipment in which provision has been made for expansion and for marked changes in loads. 4000 w. St Ry Jour—July 19, 1902. No. 49570 D.

Pied-Selle.

Electric Installation at the Piéd-Selle Works, at Fumay, Ardennes, France (Installations Electriques des Usines du Pied-Selle à Fumay, Ardennes). C. Dufour. An illustrated description of a hydro-electric plant, transmission line and electric driving in a manufactory of heating apparatus. 1 plate. 2500 w. Génie Civil—July 12, 1902. No. 49488 D.

Pike's Peak.

Power Transmission in the Pike's Peak Region. R. M. Jones. Illustrated detailed description of the dam and reservoir, wood and steel pipe line, power station, electrical equipment, etc. 2700 w. Elec Wld & Engr—July 26, 1902. No. 49651.

The Plant of the Pike's Peak Power Co. R. M. Jones. Illustrated description of a plant comprising a rock-fill dam with steel-plate face, a wood stave and steel pipe line, 26,100 ft. long, and a 1,600 k. w. power station, for which all materials had to be lowered by derrick down the face of a cliff. 3200 w. Eng Rec—July 19, 1902. No. 48556.

Pittsfield, Mass.

Power Plant of the Berkshire Street Railway Co., Pittsfield, Mass. Illustrated description of a plant with two 750 k. w. units distributing alternating current at 13,300 volts, for a 40-mile country road. Describes particularly the piping. 2000 w. Eng Rec—July 26, 1902. No. 49635.

Railway Stations.

Electric Railway Power Stations (Betrachtungen über Bahncentralen). Dr. M. Eisig. A general review of the boilers, engines, gas engines, turbines, dynamos, storage batteries and other equipment of power stations, as well as of sub-stations and distribution. Diagram. Two parts, 10,000 w. Elektrotech Zeitschr—July 3 and 10, 1902. No. 49409 each B.

Regulation.

The Girard System of Regulating Dynamos Driven by Gas Engines (Dispostif de M. Girard pour la Regularisation du Courant Electrique Fourni par un Moteur à Gaz). M. Lauriol. An automatic rheostat varies the separately excited field of the dynamo. General discussion of the problem with diagrams. 3000 w. Bull Soc Internationale des Electriciens—June, 1902. No. 49490 E.

St. Petersburg.

The St. Petersburg Central Station Built by the "Société Anonyme Electricité et Hydraulique" (Centrale der Société Anonyme "Electricite et Hydraulique" in St. Petersburg). W. Multhauf. An illustrated description with a capacity of 7000 kilowatts. 3600 w. Elektrotech Zeitschr—June 19, 1902. No. 49400 B.

Shoreditch.

The New Shoreditch Electricity Works. Illustrated description of the new works

which have been erected at Haggerston, England. 3700 w. Elec Engr, Lond—June 20, 1902. No. 49122 A.

Speed Regulation.

See Mechanical Engineering, Steam Engineering.

Station Expenses.

Expenses of Electric Stations. Alton Adams. Discusses the increase in expenses, the need of economy, and the points where the largest savings have been effected. 1500 w. Elec Rev, N Y—July 19, 1902. No. 49585.

Transformers.

The Grisson Continuous-Alternating Current Transformers. A. Frederick Collins. Illustrated description of an apparatus which changes a direct continuous current into a pure alternating-current. It is recommended especially for wireless telegraphy sets. 1200 w. Sci Am—June 28, 1902. No. 49093.

LIGHTING.

Arc Lamps.

Radiant Emciency of Arons Mercury Arc Lamp. William C. Geer. Read at the Pittsburg meeting of the A. A. A. S. A study of this subject with results. 600 w. Elec Wld & Engr—July 19, 1902. No. 49596.

The Bremer Lamp. Siegmund Saubermann. Abstract of a paper read before the Elektrotechnischer Verein of Vienna. Illustrated detailed description of the construction and the principle upon which it is based. Also gives photometric measurements of the light. 1800 w. Elect'n, Lond—June 20, 1902. No. 49121 A.

Arcs.

Arc Lighting. C. M. Green. An able and interesting paper read before the Canadian Elec. Assn. Concludes that the enclosed arc is better and cheaper than the open arc; the direct constant current enclosed arc system the best and most economical for plants devoted exclusively to arc lighting; the alternating constant current enclosed arc system the best and most economical for plants which use large 40 to 125 cycle alternating current generators. 4500 w. Can Engr—July, 1902. No. 49207.

The Alternating Current Arc. Ernst Adler. An explanation of phenomena observed in alternating current arcs. 1000 w. Elec Wld & Engr—June 21, 1902. No. 49077.

See Electrical Engineering, Electro-Physics.

Car Lighting.

See Railway Engineering, Motive Power and Equipment.

Decorative Lighting.

The Coronation Illuminations. An illustrated account of the preparations made to illuminate London in honor of the King's coronation. Also some remarks on the attitude of the companies and the precautions taken. 3200 w. Elect'n, Lond—July 4, 1902. No. 49350 A.

Mercury Lamp.

The Hewitt Mercury Vapor Lamp. Abstract translation of an article by Dr. Max V. Recklinghausen, published in the *Elektrotechnische Zeitschrift*, describing this lamp and discussing its properties. Ill. 1200 w. Elect'n, Lond—June 27, 1902. No. 49169 A.

Vacuum Light.

The Moore Electric Light. Illustrated description of the latest improved forms of the Moore vacuum light, with details from recent patents. 2500 w. Elec Wld & Engr—June 28, 1902. No. 49110.

MEASUREMENT.

Instruments.

Electrical Measurements and Measuring Instruments (Ueber Elektrische Messungen und Messinstrumente). Prof. August Raps. Lecture before the Oesterr Ing. und Arch. Verein on the elements of electrical measurement. Serial. 2 parts. 5000 w. Supplement to Zeitschr d Oesterr Ing u Arch Vereines—July 4, 11, 1902. No. 49444 each B.

Magnetic Tests.

Note on Magnetic Tests of Iron (Note sur les Essais Magnétiques du Fer). M. Armagnat. A preliminary report of a committee of the Soc. Int. des Electriciens, giving some data on testing for permeability, hysteresis, etc., making recommendations and requesting information. 1600 w. Bull Soc Internationale des Electriciens—June, 1902. No. 49494 E.

Meters.

Electric Motor-Meters and Electromagnetic Apparatus (Ueber Motorzähler und Elektromagnetische Bewegungsapparate). Dr. Th. Bruger. A paper before the Verband Deutscher Elektrotechniker, giving an illustrated account of various electric meters operating on the motor and other electromagnetic principles. 2000 w. Electrotech Zeitschr—July 3, 1902. No. 40408 B.

Principles.

Electrical Units and Introduction to Alternating Currents (Die Masse in der Elektrotechnik. Einführung in das Wechselstromgebiet). Dr. Johann Sahulka. Lecure before the Oesterr. Ing. und Arch. Verein on the elements of electrical engineering. Diagrams. 6000 w. Supplement to Zeitschr d Oesterr Ing u Arch Vereines—July 4, 1902. No. 49443 B.

Self-Inductions.

On a New Method of Measuring Small

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Self-Inductions. W. Mansergh Varley. Describes a method devised for measuring the self-inductions of some small solenoids in the course of an investigation on the magnetization of iron in rapidly-oscillating current fields. 1300 w. Elect'n, Lond—June 20, 1902. No. 49120 A.

POWER APPLICATIONS.

Cement Plant.

An Electric Cement-Making Plant. Illustrated description of a plant at Alsen, N. Y., which shows the adaptability of electric power to meet the requirements of cement-making machinery. 1000 w. Elec Wld & Engr—July 19, 1902. No. 49595.

Coal Cutting.

Three-Phase Electric Driving, Applied to Coal-Cutting. Roslyn Holiday. Gives reasons for adopting it, and some of the experiences met with before success was assured. 1500 w. Ir & Coal Trds Rev—July 18, 1902. No. 49634 A.

Cranes.

New Electric Cranes (Neuere Krane mit Elektrischem Antrieb). An illustrated description of various kinds of cranes operated electrically and manufactured by the Duisburg Machine Company. Serial. Part I. 1000 w. Zeitschr d Ver Deutscher Ing—June 28, 1902. No. 49420 D.

Electric Driving.

Advantages of Electric Transmission. F. J. A. Matthews. Discusses some points concerning the economy of electric power and steam power; the advantages of electric power, etc., showing that each case must be considered carefully to determine whether it will be economical. 3400 w. Mech Engr—July 19, 1902. Serial. 1st part. No. 49648.

Electric Driving for Shops. C. A. Seley. Read at the Saratoga Convention of the Mas. Mechs' Assn. A description of the regular motors for power purposes to be used at Roanoke shops of the Norfolk & Western Ry., the system of lighting, etc. 3200 w. R R Gaz—June 27, 1902. No. 49153.

The Driving of Centrifugal Machines. Illustrated description of an electrically-driven centrifugal made in Glasgow. 800 w. Engng—June 20, 1902. No. 49129 A.

The Electrical Equipment of the Nordberg Manufacturing Company's Plant. Illustrated description of a plant electrically driven throughout and, with the exception of the tool room, all machines are fitted with individual motors. 2500 w. Am Mach—July 3, 1902. No. 49236.

Electric Haulage.

Florence Mine. An illustrated description of some ingenious contrivances used in connection with the electric haulage system of this coal mine. 1500 w. Mines & Min—July, 1902. No. 49308 C.

Elevators.

Electric Elevators (Electrisch Betriebene Aufzüge). S. Herzog. A general discussion and illustrated descriptions of various European systems of electric elevators. Serial. Part I. 1800 w. Schweiz Bauzeitung—July 5, 1902. No. 49474 B.

Fan Motors.

Fan Motor Hints. Harry Hertzberg. Remarks on their design and use with some of the difficulties in their operation and methods of meeting them. 2500 w. Engr, U S A—June 16, 1902. No. 49072.

Hoisting Machines.

The Starting of Electric Hoisting Machines (Das Anlassen von Elektrischen Fördermaschinen). C. Köttgen. A paper before the Verband Deutscher Elektrotechniker, discussing various systems of electric hoisting for mine shafts, and especially the starting of the motor, with many diagrams. 4500 w. Elektrotech Zeitschr—July 10, 1902. No. 49411 B.

Mine Draining.

Electric Mine-Draining Plant at the Düsseldorf Exhibition. Illustrated description of an electric generating installation for working a draining pump. 800 w. Engng—July 11, 1902. No. 49541 A.

Paper Making.

Electrical Power at a Paper Mill. Illustrated description of a complete electrical power installation which has been in operation about a year at the Linwood Paper Mills, Renfrewshire, Scotland. 2000 w. Engr, Lond—July 18, 1902. No. 49632 A.

Pumping.

Electrically-Driven Centrifugal Pumps in the Horcajo Mines, Spain. Illustrates and describes a pumping plant in the lead mines of Spain. 4000 w. Engng—July 18, 1902. No. 40627 A.

Electric Pumping from a 1300-Foot Level. Donald H. Fry. Read before the Pacific Coast Elec. Trans. Assn. A brief description, with illustration, of an electrically driven pump recently installed at the Oneida mine, Amador Co., Cal. Also a comparison of electric power costs with fuel oil. 1000 w. Jour of Elec—June, 1902. No. 49506.

Proposed Electric Pumping for Stock Wells. A. J. Bowie, Jr. Read before the Pacific Coast Elec. Trans. Assn. Map and description of a proposed installation, stating the present conditions. 2200 w. Jour of Elec—June, 1902. No. 49507.

TRANSMISSION.

Continuous Current.

High-Tension Continuous-Current Systems. A. S. Barnard. Showing the advocates of the continuous-current plant are

able to offer a reliable alternative to the three-phase generator and transformer. Also brief discussion. 3800 w. Elec Engr, Lond—July 4, 1902. No. 49346 A.

High-Voltage.

The 50,000-Volt Transmission of the Missouri River Power Company. W. G. McConnon. Illustrated detailed description of a plant using the highest transmission voltage, and transmitting power for 65 miles. 2400 w. Jour of Elec—June, 1902. No. 49504.

The 50,000-Volt Transmission Plant of the Missouri River Power Company. W. G. McConnon. Illustrated detailed description. 1000 w. Am Elect'n—July, 1902. No. 49254.

50,000-Volt Transmission Plant of the Missouri River Power Co., at Cañon Ferry, Montana. W. G. McConnon. Describes a plant for transmitting electric power for 65 miles. 2000 w. Mines & Min—July, 1902. No. 49311 C.

Lightning Arresters.

Lightning Protection and the Static Interrupter. Percy H. Thomas. Considers ground and short circuits, local concentration of potential, effect of discharge of arrester, other causes of static strains, protection of apparatus, and the devices used. Ill. 6200 w. Can Engr—July, 1902. No. 49208.

Long Distance.

Success in Long-Distance Power Transmission. F. A. C. Perrine. A consideration of the problems met by the transmission engineer, the difficulties he must solve which differ from those presented in ordinary electric lines and currents. 6000 w. Tech Qr—June, 1902. No. 49325 E.

Self-Induction.

The Effects of Self-Induction and Capacity in Electric Transmission. G. H. Baillie. Considers to what extent they should be taken into account in practical work, giving formulæ applicable to the different systems of transmission. 1700 w. Elect'n, Lond—July 18, 1902. Serial. 1st part. No. 49618 A.

Surging.

Surges in Transmission Circuits. F. G. Baum. Read before the Pacific Coast Elec. Trans. Assn. Discusses opening a line under a load or short circuit; closing a high-potential line switch to charge the line; opening a high potential line switch to deaden the line. 1700 w. Jour of Elec—June, 1902. No. 49505.

MISCELLANY.

Exposition.

Electricity and Power Gas in Mining and Metallurgy (Der Bergbau auf der Düsseldorfer Ausstellung 1902. Elektricität und Kraftgas im Bergbau und Hüttenwesen). R. Goetze. Illustrated descriptions of electrical apparatus of various kinds of large gas engines. 11 plates. 7500 w. Glückauf—June 28, 1902. No. 49458 B.

Protection.

Protection of Electrical Machines. J. B. Clarke. Examines the reasons for non-protection in the case of a three-wire balanced system, showing what the balancer has to do. Ill. 800 w. Elec Rev, Lond—July 11, 1902. No. 49529 A.

Terminology.

Electrode Terminology. Albert M. Lewers. On the desirability of selecting some accurate system of designating the electrodes of secondary batteries and ending the confusion arising from the use of "positive" and "negative." 1300 w. Elec Wld & Engr—July 12, 1902. No. 49352.

GAS WORKS ENGINEERING

Acetylene.

The Actual State of the Calcium Carbide and Acetylene Industries (L'Etat Actuel de l'Industrie du Carbure de Calcium et de l'Acetylène). Dr. Oscar Münsterberg. Translated from *Zeitschrift für Beleuchtungswesen.* A general review of acetylene lighting, which the author believes is the best illuminating system for small cities and isolated buildings. 4500 w. Rev Gén des Sciences—June 15, 1902. No. 49496 D.

Analysis.

The Analysis of Blast-Furnace and Generator Gases (Analyse der Hochofen und Generatorgase). A. Wencelius. A supplement to a previous article, giving an illustrated description of apparatus for gas analysis and its manipulation. 2000 w. Stahl u Eisen—June 15, 1902. No. 49447 D.

Blowing and Exhausting.

The Steam Turbine as Applied to Blowing and Exhausting Apparatus. W. D. Child. Read before the Gas Inst. (England). A description of the construction and working of the apparatus. Ill. Discussion. 7700 w. Gas Wld—June 14, 1902. No. 49066 A.

Burners.

Maintenance of Incandescent Gas Burners by Gas Companies. Norton H. Humphrys. Read before the Gas Inst., (England). Describes the methods adopted in regard to both private and public lighting.

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2000 w. Gas Wld—June 14, 1902. No. 49-063 A.

The Maintenance of Incandescent Burners in Private Houses and Public Lamps. George Helps. Discusses two cases of private lighting maintenance, standard of efficiency in public lighting, results and particulars. Ill. 3800 w. Gas Wld—July 19, 1902. No. 49624 A.

Coke-Conveyor.

A New Coke-Conveyor at the Cassel Gas-Works. Illustrated abstract translation of a description in the *Journal für Gasbeleuchtung*, by Herr E. Merz, of a recent installation of a modified De Brouwer conveyor. 2000 w. Jour Gas Lgt—July 1, 1902. No. 49265 A.

Distribution.

Efficiency and Economy in Gas Distribution. Walter Hole. Read before the Gas Inst. (England). Gives a brief description of remodeling and enlarging of mains in Leeds, and discusses matters affecting the distribution. Discussion. Ill. 7000 w. Gas Wld—June 14, 1902. No. 49068 A.

Enrichment.

Enrichment of Gas by Benzol. A. Lecomte. Read before the Société Technique du Gaz en France. Describes apparatus employed in the process, giving tests made. Ill. 1200 w. Jour Gas Lgt—July 8, 1902. No. 40565 A.

Explosion.

Movements of the Flame in the Explosion of Gases. Harold B. Dixon. Abstract of a paper read at meeting of the Royal Society, on the extensive researches made by the writer. 6000 w. Jour Gas Lgt—July 1, 1902. No. 49264 A.

Gas Oils.

The Valuation of Gas Oils. John P. Leather. Read before the Gas Inst. (England). Discusses the constitution of the different classes of hydrocarbons found in petroleum and their bearing on the variations of the gas-producing qualities of the different oils. Also gives an outline of a method by which an oil may be examined for the amounts of the compounds composing it. Discussion follows. 4200 w. Gas Wld—June 14, 1902. No. 49067 A.

Heating.

Heating by Gas: A Study of the Gas Radiators of the Société Francaise de Chaleur et Lumiere. M. A. Lecomte. Abstract translation of paper read at meeting of the Société Technique de l'Industrie du Gaz en France. Gives calorimetric experiments and calculations, examinations of the air and the mode of combustion. Ill. 2300 w. Gas Wld—June 28, 1902. No. 49-161 A.

Illuminants.

Some Modern Competitors with Coal Gas. A. Lecomte. Read before the recent congress of the Société Technique du Gaz en France. Brings up to date the technical details in regard to the illuminants, carburetted gas, "alcoholene," petroleum, and alcohol, devoting most attention to the last named. 2000 w. Jour Gas Lgt—July 1, 1902. No. 49266 A.

Measurement.

A New System of Gas Measurement. T. G. Marsh. Read before the Gas Inst. (England). A description of an apparatus that may serve the purpose of the station meter in a gas-works, or, within limits, of a consumer's meter. Discussion. 4800 w. Gas Wld—June 14, 1902. No. 49069 A.

Public Lamps.

Automatically Lighting and Extinguishing Public Lamps. W. R. Mealing. Read before the Gas Inst. (England). Describes the Gunning system and its operation. Short discussion. 3200 w. Gas Wld—June 14, 1902. No. 49070 A.

Smoke Prevention.

A New Method of Smoke Prevention (Ein Neues Verfahren zur Vollständigen Beseitigung und Unterdrückung des Schornstein-Rauches). Br. Böhm-Raffay. A description of the Tobiansky d'Altoff process in which the products of combustion of an ordinary furnace are carburetted to make so-called "pyrogas." 3000 w. Zeitschr d Oesterr Ing u Arch Vereines—June 13, 1902. No. 49439 B.

Standardization.

The Standardization of Screws for Gas Connections. J. Payet. Read before the Société Technique de l'Industrie du Gaz en France. Describes the international system in use for rods and bolts and explains how it may be applied to gas connections. 800 w. Prac Engr—July 4, 1902. No. 49-342 A.

INDUSTRIAL ECONOMY

Africa.

Labor Conditions in Johannesburg. T. Lane Carter. A statement of the labor conditions of the past, and the future outlook. 2000 w. Eng & Min Jour—July 12, 1902. No. 49393.

Anthracite Mining.

Anthracite Mining Conditions. Review of statement issued by John Mitchell, President of the United Mine Workers, showing that the case of the strikers has not been truthfully presented. 3100 w. Eng & Min Jour—June 28, 1902. No. 49105.

Education.

Commercial Education in Japan. Information concerning the schools and their

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courses of study. 1800 w. Engng—July 4, 1902. No, 49370 A.

The Economic Need of Technical Education. Victor C. Alderson. Describes the schools for technical education in Switzerland and discusses the need in the United States. 5400 w. Jour W Soc of Engrs—June, 1902. No. 49298 D.

The Efficiency Factor in Engineering Education. Robert Fletcher. Condensed from the presidential address before the Soc. for the Promotion of Engng. Ed. Brief discussion of the substance, methods, machinery and cost of engineering education. 2400 w. Eng News—July 3, 1902. No. 49274.

The Practical Mechanic vs. the Mechanical Engineer. Editorial discussing executive ability, where the college man falls short, where he should begin, etc. 800 w. Loc Engng—July, 1902. No. 49204 C.

Exhibition.

Carlisle Show. Illustrated description of some of the implements exhibited at this show of the Royal Agricultural Society of England. 9700 w. Engng—July 11, 1902. No. 49538 A.

Premium Plan.

Shop Record System of the Pearson Machine Company. Describes methods in use in a shop which manufactures turret lathes, screw machines, forming and drilling machines, and horizontal boring machinery. 1300 w. Ir Trd Rev—July 3, 1902. No. 49224.

The Premium Plan at the Blank Blank Engineering Works. Gives figures showing in detail and in summary the workings of the premium plan as a whole in a plant which employs about four hundred men in all departments. 2000 w. Am Mach—June 26, 1902. No. 49088.

Prices.

The Trend of Prices in Engineering Industries. C. L. Redfield. A discussion of the influence of the increasing output and declining value of gold upon prices in connection with engineering work. 2500 w. Engineering Magazine—August, 1902. No. 49701 B.

Shipping Combine.

British and American Shipping. Benjamin Taylor. A discussion of the recent developments in maritime affairs, known as the "shipping combine." 6200 w. Nineteenth Cent—July, 1902. No. 49532 D.

The Steamship Merger and American Shipbuilding. Charles H. Cramp. Briefly reviews the history of transatlantic construction and navigation, showing the conditions which existed and the effect which the merger is likely to have, and considering the probable effect upon shipbuilding. 4500 w. N Am Rev—July, 1902. No. 49300 D.

Strikes.

A General View of the Coal Strike. Talcott Williams. An explanation of conditions existing in the coal fields. 1700 w. Rev of Revs—July, 1902. No. 49328 C.

Strikes and the Public Welfare. John Handiboe. Advocating compulsory arbitration in troubles between capital and labor. 3000 w. N Am Rev—July, 1902. No. 49301 D.

Workshop Conditions.

Some Unacknowledged Conditions in British Workshops. T. Good. Interesting revelations concerning the prevalence of exactions by foremen upon the workmen, and their influence upon the works management. 2500 w. Engineering Magazine—August, 1902. No. 49705 B.

Works Management.

Money Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter's seventh paper discusses the various methods of the remuneration of workmen, including day work, piece work, and other wage systems. 5000 w. Engineering Magazine—August, 1902. No. 49708 B.

Some Aspects of Workshop Management. The first of a series of articles from the point of view of the British manufacturer, discussing systems of management, as they should be conducted. 2300 w. Engr, Lond—July 4, 1902. No. 49371 A.

MARINE AND NAVAL ENGINEERING

Boat-Launching.

The Peterson Boat-Launching Apparatus. An illustrated description of a system designed to meet severe requirements. 900 w. Sci Am Sup—June 28, 1902. No. 49094.

Chain Boats.

Chain Boats on the River Elbe. An account of the use of a chain for propelling steamers, which has proved an economical and successful means of navigating the swift current of this river. Ill. 1700 w. U S Cons Repts, No. 1384—July 5, 1902. No. 49148 D.

Coaling Plant.

Coaling Plant for the U. S. Navy at East Lamoine, Frenchman's Bay, Maine. J. A. McNicol. Brief illustrated description. 1300 w. Eng News—July 24, 1902. No. 49658.

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Cruiser.

The Russian Cruiser Askold. Illustration, with description, of a type of vessel of interest because it is the result of competition in design, and because it represents a type discarded by all other nations. 1400 w. Engr, Lond—July 4, 1902. No. 49376 A.

Dry Docks.

Dry Docks—Their Origin and Developbent. Parker H. Kemble in the *Boston Evening Transcript*. Reviews the various systems of reaching the bottoms of vessels for repairs, especially the docking of vessels. 2500 w. Marine Rev—July 24, 1902. No. 49686.

Testing the New Bermuda Dock. Harold J. Shepstone. An illustrated description of the test of this large dock by lifting the battleship "San Pareil." 1000 w. Sci Am—July 12, 1902. No. 49397.

Fog Signals.

Coast Fog Signals. N. G. Gedye. Read before the Civ. & Mech. Engrs'. Soc. Deals with the signals established on the coasts where fog is prevalent, for the guidance of the mariner. Ill. 2800 w. Engr, Lond—July 4, 1902. Serial, 1st part. No. 49378A.

German Fleet.

The Kaiser's Fleet. Archibald S. Hurd. Discusses the naval policy of Germany, the German Naval Bill of 1900, which authorizes the expenditure of 73,000,000 l. on new men-of-war and 13,000,000 l. on dockyards, and related matters of interest. 4500 w. Nineteenth Cent—July, 1902. No. 49533D.

Germany.

The Iron Industry and Shipbuilding in Germany (Eisenindustrie und Schiffbau in Deutschland). E. Schrödter. Abstact of a paper before the Schiffbautechnische Gessellschaft at Düsseldorf, giving an account of the growth of the German shipbuilding and iron industries, and comparisons with other countries. Diagrams and tables. Serial, Part I. 5000 w. Stahl u Eisen—July 1, 1902. No. 49448D.

Launch.

An Experimental Electric Launch. Prof. Oswald Flamm. Translated from *Schiffbau*. Illustrates and describes a boat built by the Watt-Accumulator Works in Zehdenick, on the Havel. 900 w. Marine Engng—July, 1902. Serial. 1st part. No. 49248C.

Marine Engines.

Balancing Marine Engines. Prof. W. E. Dalby. Read before the Inst. of Nav. Archts. A comparison of five types of engines with respect to their inertia forces and couples, their increases in weight due to the addition of balance-weights, and the variations of turning moment on their crankshafts. 4000 w. Engng—July 11, 1902. No. 49542A.

Navigation Congress.

International Navigation Congress at Düsseldorf. Begins a report of the proceedings, dealing very briefly with the subjects presented. 5000 w. Engng—July 4, 1902. Serial. 1st part. No. 49369A.

Oil Burning.

First Oil-Burning Steamship Built in the United States. Brief illustrated description of the "Nevadan," built at Camden, N. J., for the trans-Pacific trade. 500 w. Sci Am—July 19, 1902. No. 49571.

Projectiles.

Capped Armor-Piercing Projectiles. Discusses briefly the penetration of plates, and the action of capped projectiles. 1500 w. Engr, Lond—June 27, 1902. No. 49179A.

Propellers.

Screw Propellers and Negative Slip. Robert M. Neilson. The writer's opinions on this subject, discussing several forms of propellers, and their action. 1800 w. Prac Engr—June 20 1902. No. 49118A.

Schooner.

Successful Launch of 7-Master. Describes the new seven-masted steel schooner, "Thomas W. Lawson," and the Fore River shipyard. 2300 w. Naut Gaz—July 17, 1902. No. 49578.

Shipbuilding.

A Remarkable Shipbuilding Feat, 13,000 Feet Above the Sea Level. An account of the construction and delivery of a steamship to be used on Lake Titicaca, 13,000 ft. above the sea. Ill. 1700 w. Sci Am—July 12; 1902. No. 49395.

Modern Shipway Equipment and Its Future Development. Tjard Schwarz. Translated from the *Jahrbuch der Schiffbautechnischen Gessellschaft*. Illustrates and describes recent devices for handling materials and for machine work. 8000 w. Marine Engng—July, 1902. Serial. 1st part. No. 49249C.

Progress of Warships and Machinery Building in England. A résumé of progress made in naval construction during the last six months. 2200 w. Engr, Lond—June 27, 1902. No. 49180 A.

Steamboat Building Under Difficulties. Edwin B. Sadtler. Illustrated discription of the building of the hull of the new steel steamer "Sagamore," which has been constructed on the shores of Lake George, in the village of Caldwell. 2200 w. Marine Engng—July, 1902. No. 49244 C.

Shipping.

The Messageries Maritimes. Information concerning this great French steamshipping concern, especially a report of this

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last year. 1000 w. Engng—July 4, 1902. No. 49367A.

Shipyard.

The Fore River Ship Building Shed. Illustrated description of a roof with 185 ft. clear span and 60 ft. overhang on either side and rising about 100 ft. above the floor. 1200 w. Eng Rec—July 26, 1902. No. 49641.

Steamboat.

New Excursion Steamboat. Brief description, with illustration, of the Nantasket, latest addition to the fleet in Boston harbor. 700 w. Naut Gaz—July 24, 1902. No. 49673.

Steamers.

New Passenger Propeller. Illustrated description of the "General Putnam," built for the New York and Greenwich route. 3300 w. Naut Gaz—July 10, 1902. No. 49517.

Pilot Steamer for Port Philip Harbor. Illustration and brief description of a steamer constructed completely in Australia. 300 w. 2-page plate. Engng—June 27, 1902. No. 49177A.

The Twin-Screw Steamers "Winifred" and "Sybil." Illustrated description of sister-boats built for the Uganda Railway, and intended to ply on the Lake of Victoria. 1300 w. Engng—June 20, 1902. No. 49128A.

Submarines.

Submarine Weapons in the Nineteenth Century. (Le Armi Subaquee nel Secolo XIX). Quintino Bonomo. A general review from the early experiments of Fulton, with especial reference to torpedoes. 10000 w. 3 plates. Rivista Marittima—June, 1902. No. 49710 H.

Tail Shafting.

Tail Shafting for Marine Engines. J. P. Badenhausen. Discusses the causes of breakage in propeller shafting, under the heads of poor material, strains, and corrosion. Ill. 2000 w. Marine Engng—July, 1902. No. 49246 C.

Turbo-Steamers.

Marine Steam Turbines. Comments on the experience gained with the turbo-motored steamers, "King Edward" and "Queen Alexandra," and the probability of this class of engine being extensively used. Ill. 600 w. Sci Am—July 19, 1902. No. 49570.

Yachts.

Steam Yacht Helenita. Illustrated detailed description of a handsome new steel yacht built for Frank J. Gould. 1300 w. Marine Engng—July, 1902. No. 49243C.

The President's Sumptuous Yacht. Describes the refitting of the *Mayflower*, the official yacht for the use of the president of the United States. 1000 w. Bul Am Ir & Steel Assn—July 25, 1902. No. 49612.

Yawl.

The Cruising Yawl "Windward." Brief illustrated description of a vessel designed to be as safe as possible and easily handled by a small crew. 700 w. Marine Engng—July, 1902. No. 49245 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accidents.

The Causes of Automobile Accidents. M. C. Krarup. A presentation of the principal new factors introduced through automobilism, and affecting the safety of traffic on the highways. 4200 w. Horseless Age—July 16, 1902. Serial. 1st part. No. 49554.

Berlin Exhibition.

The German Automobile Exhibition at Berlin, 1902 (Die Deutsche Automobil-Ausstellung in Berlin, 1902). A general review of the automobiles exhibited, with some details. Ill. 1500 w. Zeitschr d Ver Deutscher Ing—June 14, 1902. No. 49415D.

Brakes.

Brake Test Demonstrations in Philadelphia. An account of a series of braking demonstrations before members of the city government, with results. 2300 w. Horseless Age—July 2, 1902. No. 49215.

Carburetter.

The Buck Carburetter. Illustrated description of a carburetter used in connection with a small stationary petrol engine where its carburetting action has been shown to be economical and efficient. 800 w. Autocar—July 19, 1902. No. 49613 A.

Condensers.

Atmospheric Steam Condensers. J. S. V. Bickford. An article objecting to some statements made by Mr. Stevens in regard to the efficiency of air condensers, and giving a report of experiments made and their results. 1800 w. Horseless Age—June 25, 1902. No. 49082.

Gasoline Vehicles.

How to Operate a Gasoline Carriage. Albert L. Clough. Discusses important points in the handling of the machine. 2800 w. Horseless Age—July 2, 1902. No. 49213.

Industrial Vehicles.

Commercial Possibilities of the Electric

Industrial Wagon. Frederick J. Newman. Discusses some of the problems to be solved, and considers the outlook encouraging. 2200 w. Horseless Age—July 2, 1902. No. 49214.

Kerosene Burners.

Experiments with Kerosene Burners. Henri G. Chatain. Gives illustrated descriptions of burners which represent the general line along which most burners are constructed, endeavoring to show why they fail. 2000 w. Horseless Age—June 25, 1902. No. 49083.

Long Run.

A 97 Mile Run by an Electromobile. An account of a run of ninety-seven miles on one charge, made by a British electric vehicle. 1400 w. Autocar—June 21, 1902. No. 49117 A.

Races.

The Paris-Vienna and Gordon-Bennett Races. An account of these interesting races, with illustrations of the vehicles. 6000 w. Auto Jour—July 5, 1902. No. 49341 A.

The Paris-Vienna Motor Car Race. Begins a review of these races, the race for the Gordon-Bennett cup having occurred at the same time, with interesting comments on the industry and illustrations of vehicles. 2800 w. Engr, Lond—July 11, 1902. Serial, 1st part. No. 49543 A.

The Paris-Vienna Race. A full account of the race, with illustrations of the vehicles. 6500 w. Autocar—July 5, 1902. No. 49330 A.

Racing Car.

The 40 H. P. Gear Driven Napier, Built for the Gordon-Bennett Race. Brief description with illustration. 600 w. Autocar —June 28, 1902. No. 49160 A.

Speed Trials.

American Speed Trials. An account of the Staten Island races on May 31, describing the track, vehicles and the unfortunate accident. Ill. 3000 w. Autocar—June 21, 1902. No. 49116 A.

Steam and Gasoline.

Automobilism (Ueber Selbstfahrwesen). Captain Engels. A paper before the Verein für Eisenbahnkunde giving illustrated descriptions of various styles of gasoline and steam vehicles, and advocating their use instead of light railways in Germany and her colonies; with discussion. 10000 w. Glasers Annalen—July 1, 1902. No. 49426 D.

Steam Vehicles.

Adams Express Company's Steam Wagon. Illustrated description of a 2-ton wagon which has had two years actual use. Also particulars of a heavier model recently designed. 1600 w. Ir Trd Rev—July 3, 1902. No. 49226.

English Gardner-Serpollet Steam Cars and the British Power Traction and Lighting Company's Works. Illustrated detailed description of the system, and of the York works. 5000 w. Auto Jour—June 28, 1902. Serial. 1st part. No. 49162 A.

The First Steam Carriage. Angus Sinclair. Reviews the early history of steam engineering, and gives the credit of the first steam carriage to Robert Trevithick. 1200 w. Auto Mag—July, 1902. No. 49280 C.

Storage Batteries.

The Storage Battery and the Motor Car. Thomas A. Edison. An account of the writers' new battery and the tests it has undergone in its application to automobiles. 1300 w. N Am Rev—July, 1902. No. 49299 D.

Tractor.

The Tractor in Lumbering Operations. An illustrated description of a freighting engine in use in California, and the results accomplished. 900 w. Sci Am—June 28, 1902. No. 49092.

Trials.

Competitive Trials of Parts. Albert L. Clough. Suggests the testing of the various parts of motor vehicles, such as batteries, coils, spark plugs, sparking generators, radiators, lock-nuts, lamps, tires, etc. 1000 w. Horseless Age—July 9, 1902. No. 49501.

The Motor Bicycle Endurance Contest. C C. Bramwell. An account of the run from Boston on July 4th to New York. Ill. 800 w. Horseless Age—July 9, 1902. No. 49502.

HYDRAULICS.

Alpine Water-Power.

The Utilization of the Water Power of the French Alps (L'Utilisation des Chutes D'Eau dans les Alpes Françaises) R. Tavernier. A review of the possibilities of the hydraulic power of the French Alps, comparing the progress made in Italy and Switzerland, and discussing the conditions of profitable exploitation. 15000 w. Mem d l Soc d Ing Civils de France—May, 1902. No. 49476 G.

Baths.

Public Baths at the Paris Exposition (Ueber Arbeiter und Volkbäder, Waschvorrichtungen und Aborte auf der Weltausstellung Paris 1900). Anton Schnabel. Abstract of an illustrated report to the Austrian Government on public baths and washing facilities shown at the Paris Exposition, and account of a large public bath at Brussels. 3 plates. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 7, 1902. No. 49430 B.

The Bathing Arrangements at the Austrian Government Salt Works (Ueber

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Badeeinrichtungen bei den K. K. Salinen). Anton Schnabel. An illustrated description of the baths and washing arrangements for the workmen of the Austrian salt mines. 3 plates. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 28, 1902. No. 49434 B.

Drainage.

House Drainage. A. B. Raymond. Read before the Mich. Engng Soc. On the proper manner of constructing the drains and pipes. 2000 w. Munic Engng—July, 1902. No. 49285 C.

Mine Pumping.

The Advantages and Disadvantages of Different Mine-Pumping Systems (Vorzüge und Nachteile Verschiedener Wasserhaltungs-Systeme). F. Schulte. A comparative discussion of the costs of steam and electric pumping for mines. Tables. 1800 w. Glückauf—June 21, 1902. No. 49457 B.

Plumbing.

Plumbing Regulations Criticised. Extract from a paper by Paul Gerhard, read before the health officers at Burlington, Vt. 2000 w. Dom Engng—June 25, 1902. No. 49104 C.

Water Supply in the Carnegie Residence, New York. Illustrated description of the remarkably complete work in a 70x130 ft. 4-story residence. 3000 w. Eng Rec—July 5, 1902. No. 49197.

Pumping.

See Electrical Engineering, Power Applications.

Pumping Engine.

Duty Test of a 6,000,000-Gallon Pumping Engine, Haverhill, Mass. Reviews a test, made under service conditions, of a horizontal cross-compound flywheel pump. 1200 w. Eng Rec—July 12, 1902. No. 49319.

Water-Power.

The Concord, N. H., Water Power Plant. An illustrated description of the plant and an account of its service. 2800 w. Elec Wld & Engr—July 12, 1902. No. 49351.

The Hydraulic End of Power Transmissions. John S. Eastwood. Read before the Pacific Coast Elec. Trans. Assn. Considers the water storage works, the conduit, the pipe lines, the water wheels and tail race. 4000 w. Jour of Elec—June, 1902. No. 49508.

MACHINE WORKS AND FOUNDRIES.

Accounting.

A New Factory Cost Accounting System. Wilfred Bancroft. Describes a method devised to furnish the fullest possible information about every operation, on every piece, in a machine containing some 1,500 pieces. 3800 w. Am Mach—July 24, 1902. No. 49655.

Aluminothermy.

Aluminum as a Reducing and a Heat-Producing Agent. H. O. Hofman. Reviews the commercial application of aluminum as a reducing agent, describing the processes. 4000 w. Tech Qr—June, 1902. No. 49322 E.

The Goldschmidt Aluminothermic Process and Its Applications (Das Goldschmidt'sche Aluminothermische Verfahren zur Erzeugung Hoher Temperaturen und seine Technischen Anwendungen). An illustrated account of applications of the thermite process in which high temperatures are evolved by the combustion of aluminum, to welding and mending. 1500 w. Glasers Annalen—June 15, 1902. No. 49424 D.

Annealing.

A Handy Heating and Annealing Oven. Walter J. May. Illustrates and describes an arrangement which can be used for an oven from 4 ft. to 20 ft. in length, in which it is possible to heat regularly from end to end either tubes, bars, or other forms of wrought material. 1300 w. Prac Engr—July 11, 1902. No. 49527 A.

Belting.

A Diagram for the Solution of Problems in Belting. Frank A. Kleinhans. Diagram is given and applications shown. 350 w. Am Mach—July 10, 1902. No. 49515.

Bridge Works.

The New Pittsburg Plant of the American Bridge Company. Plan and description of new works now being constructed 2500 w. Ir Age—June 26, 1902. No. 49075.

Brown, Boveri & Co.

The Electric Manufacturing Works of Brown, Boveri & Co. at Mannheim, Germany (Die Fabrikanlagen von Brown, Boveri & Cie. A. G. in Käferthal bei Mannheim). A well-illustrated description of works for the manufacture of electrical apparatus, where electric driving is employed 1200 w. Zeitschr d Ver Deutscher Ing—June 21, 1902. No. 49417 D.

Cams.

A Cam Cutting Attachment for the Milling Machine. Brief illustrated description. 400 w. Am Mach—July 10, 1902. No. 49510.

Chains.

Chains and Their Manufacture. An illustrated article discussing the various types and their manufacture. 3600 w. Ir Age—July 3, 1902. No. 49136.

Making Fifty-Ton Anchor Chains. Brief illustrated description of the manufacture of these chains at Lebanon, Pa. 700 w. Sci Am Sup—July 12, 1902. No. 49399.

Channelling.

Oil-Way Channelling Machine. Illus-

tration, with description, of a machine for cutting the oil channels in journal brasses. 700 w. Engng—July 4, 1902. No. 49366 A.

Cranes.

Notes on Crane Design. Concerning the advantages and disadvantages of wire rope and chains, and other points in crane machinery. 1000 w. Am Mach—July 17, 1902. No. 49599.

See Electrical Engineering, Power Applications.

Cutting-Off.

German Cold Saw Cutting-Off Machines. Illustrations with brief descriptions of three machines made in Würtemberg. 500 w. Am Mach—July 17, 1902. No. 49600.

Designs.

From a Designer's Note Book. Brief sketches describing nuts, clamps, pulleys, etc. 1200 w. Am Mach—June 26, 1902. No. 49089.

Dies.

A Bending and Forming Die. C. H. Rowe. Illustrated description of die and punch. 600 w. Am Mach—July 24, 1902. No. 49656.

A Combination Blanking Die. William Doran. Illustrated description. 600 w. Am Mach—July 10, 1902. No. 49512.

A Complete Set of Dies for the Manufacture of Sheet Metal Hinges. Joseph V. Woodworth. Illustrated description of dies used for manufacturing sheet metal hinges and latches for grape crates at a minimum cost. 1200 w. Am Mach—July 3, 1902. No. 49238.

A "Follow-Die" Which Draws, Pierces, End-Finishes, Cuts Off and Bends in One Operation. Joseph V. Woodworth. Illustrates and describes the die and its operation. 600 w. Am Mach—June 26, 1902. No. 49085.

A Set of Dies for Rectangular Tin Boxes. Joseph V. Woodworth. Description and illustrations of dies for the production of vaseline boxes and covers. 1800 w. Am Mach—July 17, 1902. No. 49601.

Drawings.

Shop Drawings. A full description of the system in use at the shops of Messrs. David Rowan and Co. 3000 w. Engng—July 27, 1902. No. 49174 A.

Electric Driving.

See Electrical Engineering, Power Applications.

Ellipse.

A Ready Construction of the Ellipse. W. S. Buvinger. Gives curves giving radii for all ellipses at angles of 15, 30 and 60 degrees, measured from the center line. The curves have been constructed from mathematical calculation and are sufficiently accurate for ordinary work. 300 w. Am Mach—June 26, 1902. No. 49087.

Engineering Works.

Royles Engineering Works, Irlam. Illustrated description of new works, covering about five acres, near Manchester, England. They consist of iron and brass foundries, pattern shop and stores, machine and erecting shop, offices, etc. 1500 w. Engr, Lond—July 4, 1902. No. 49377 A.

Forced Fits.

Forced and Shrink Fits. C. D. King. Describes methods and explains the action of the metals and why the rough surface holds stronger than the very smooth. 800 w. Sci Am—June 28, 1902. No. 49090.

Forging Steel.

The Imperative Conditions for Forging Steel. From a paper by H. F. J. Porter, before the Engine Builders' Assn at Pittsburg. Briefly describes the processes considered necessary to manufacture the grade of forgings used by engine builders. 1800 w. Am Mach—July 3, 1902. No. 49239.

Grinding.

Grinding Machines and Processes. Joseph Horner. Describes recent developments in machines and their operation, new processes, etc. Ill. 3500 w. Engng—July 4, 1902. Serial. 1st part. No. 49364 A.

Surface Grinding Attachment for a Universal Grinder. Illustrations, with description. 600 w. Am Mach—July 24, 1902. No. 49654.

Hardening.

Hardening Thin Cutters. E. R. Markham. Hints as to methods of heating and arrangement of plates for cooling the work. Ill. 1200 w. Am Mach—June 26, 1902. No. 49086.

Laboratory.

Physical and Chemical Laboratory of the J. I. Case Threshing Machine Co., Racine, Wis. Illustrated description of this laboratory and the important features of the work. 3800 w. Eng News—July 10, 1902. No. 49387.

Lathe.

Automatic Screw-Cutting Lathe. Illustrates and describes a lathe which will cut screws up to 2 in. in diameter. Its movements are automatic, and right or left threads may be cut. 2000 w. Engng—July 18, 1902. No. 49629 A.

Machine Tools.

Copper Stay-Making Machines. Illustrates and describes an ingenious automatic tool. 1200 w. Engr, Lond—July 4, 1902. No. 49375 A.

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Machine Works.

The Jones and Lamson Machine Co.'s Plant and Methods. Illustrated detailed description of a plant at Springfield, Vt. 4500 w. Ir Trd Rev—July 3, 1902. No. 49225.

Manufacturing Plant.

Some Features of the Works of the Stanley Elec. Mfg. Co. Illustrated description of the general arrangement of an electric manufacturing plant and the details of the power plant. 2700 w. Eng Rec—July 5, 1902. No. 49193.

Paints.

Anti-Corrosive Paints; Their Qualities and Composition. Discusses the capabilities of many of the so-called anti-corrosive paints in use, and offers suggestions for the production of a perfect painting compound. 4000 w. Engng—June 27, 1902. No. 49173 A.

Patterns.

Patterns with Branches. I. McKim Chase. Illustrates the application of geometry to practical pattern making. 1500 w. Mach, N Y—July, 1902. No. 49252.

Premium System.

See Industrial Economy.

Shafting.

Shafting Hints. Charles Herrman. Calls attention to difficulties arising in connection with shafting, and gives suggestions for overcoming them. Ill. 2000 w. Power —July, 1902. No. 49140 C.

Tool Steels.

New Tool Steels and Their Advantages. A review of special steels now made, with report of tests showing character, and information concerning their use. 6800 w. Ir & Coal Trds Rev—June 20, 1902. No. 49134 A.

Variable Speed.

A New Variable Speed Mechanism. Walter Ferris. Illustrates and describes a recently invented device called a cone pulley transformer. 900 w. Am Mach—July 3, 1902. No. 49240.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Notes on the Practical Melting of Alloys. Percy Longmuir. Deals with practical methods of producing good examples of the alloys used in the industrial arts. 1800 w. Prac Engr—June 20, 1902. No. 49119 A.,

The Constitution of Alloys (La Constitution des Alliages). Leon Guillet. A comprehensive study of alloys and their physical, chemical and electrical properties. Diagrams and tables. Serial. Part I. 3000 w. Genie Civil—June 28, 1902. No. 49486 D.

Upon the Structure of Metals and Binary Alloys. William Campbell. Discusses methods of obtaining a knowledge of the structure, the crystalline structure, the effects of strain and the effect of heat treatment. Ill. 2900 w. Jour Fr Inst—July, 1902. Serial. 1st part. No. 49291 D.

Emery.

A Speed Trial of Emery Wheels as to Strength. T. Dunkin Paret. Gives information from Prof. Grübler's preliminary report concerning tests made in Germany to arrive at some verified data as to the speed which solid emery wheels could safely endure. 1300 w. R. R. Gaz—July 11, 1902. No. 49353.

Steel.

The Selection of Steel for Various Articles. Begins a list of a series of articles, giving the carbon contents which have been found by experience to be the most suitable for the purpose to which the steel has been put. 1800 w. Serial. 1st part. Ir Age—July 10, 1902. No. 49279.

Stresses.

A Diagram for the Combination of Direct and Shearing Stresses. E. R. Douglas. Gives diagram and explanation of its use. 600 w. Am Mach—July 10, 1902. No. 49511.

An Investigation Into the Stresses on the Framework of a Destroyer's Engines. Jasper E. Cooper. The present article investigates the stresses caused by the dead weight of the cylinders, by the steam pressure on the cylinder covers, by the steam pressure on the piston valves, and by the steam pressure transmitted to the guides by the connecting rod. 2000 w. Prac Engr—June 27, 1902. Serial, 1st part. No. 49159 A.

Testing.

The Accuracy and Value of Testing Cast Iron. Dr. Richard Moldenke. A discussion of American practice in testing, showing the aim to be the determination of the true value of the material apart from any particular casting. 2000 w. Engineering Magazine—August, 1902. No. 49706 B.

Testing Machine.

Experience with a Simple Babbitt Testing Machine. E. S. Farwell. Read before the Am. Assn. for the Ad. of Science. Illustrates and describes the machine and the improvements made upon it. 1600 w. Am Mach—July 24, 1902. No. 49657.

Tin-Plate.

The Manufacture of Tin-Plate. W. H. Tregoning. A review of this industry and the uses made of the tin-plate, the raw ma-

terials, the manufacture, etc. 4000 w. Ir. & Coal Trds Rev—June 20, 1902. No. 49133 A.

Lubricants.

Valve Oil. Editorial discussion of some of its characteristics, rate of feed in lubricators, fire test, effects of thick oil, packing boxes, etc. Loc Engng—July, 1902. No. 49203 C.

MEASUREMENT.

Calorimeter.

A Simple Form of Fuel Calorimeter. Charles R. Darling. Illustrated description of an instrument for which is claimed the advantages of simplicity in working, a visible combustion completely under control, and considerable accuracy. 1600 w. Engng—June 20, 1902. No. 49127 A.

Dynamometer.

A Water Dynamometer. Illustrates and describes a machine originally designed by William Froude for use in experiments on the propulsion of ships, but since modified for use with stationary engines. 1400 w. Engr, Lond—June 20, 1902. No. 49126 A.

Indicators.

Notes on Indicator Cards from Air Cylinders. Ward Raymond. Gives the principal uses of an indicator on the air cylinder, the characteristics of the various lines, tables of pressures, etc. 2000 w. Compressed Air—July, 1902 No. 49671.

Novelties in Spring Steam Gauges, Indicators and Valves (Neuerungen an Federmanometern, Indikatoren und Ventilen). P. H. Rosenkranz. Paper before the Hanover Section of the Verein deutch. Ing., giving illustrated descriptions of instruments and apparatus made by Dreyer, Rosenkranz & Droop. 2200 w. Zeitschr d Ver Deutscher Ing—July 5, 1902. No. 49422 D.

Metric System.

The Metric System of Weights and Measures. Report of committee with general discussion. 8500 w. Jour Fr Inst—June, 1902. No. 49143 D.

Microscopic Measurements.

A Method of Measuring Objects in the Microscope. Frederick E. Ives. Directions with illustrations. 400 w. Jour Fr Inst—July, 1902. No. 49294 D.

Planimeter.

An Improved Arrangement of the Hatchet Planimeter. Frank B. Kleinhans. Shows the method of using the instrument. Ill. 800 w. Am Mach—July 17, 1902. No. 49602.

POWER AND TRANSMISSION.

Belts.

Belt-Problems. Shows how to overcome the difficulties met in making calculations where belts are employed. 2500 w. Prac Engr—June 27, 1902. No. 49158 A.

The Elasticity of Belts Taken from Different Parts of a Hide (Die Elastizität der an Verschiedenen Stellen einer Haut Entnommenen Treibriemen). C. Bach. An account of tests of leather belts to determine the elasticity and elongation of different parts of a hide. Tables and curves. 1500 w. Zeitschr d Ver Deutscher Ing—July 5, 1902. No. 49421 D.

Compressed Air.

Air Compressors at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902. Die Luftkompressoren). Hr. Müller. An illustrated description of various kinds of air compressors, particularly of those used for mining purposes. 8 plates. 3500 w. Glückauf—June 21, 1902. No. 49455 B.

Raising Liquids from Shafts, Boreholes, etc., by Means of Compressed Air. Victor Petit, in *Petroleum Industrial and Technical Review.* Illustrated descriptions of methods used. 1500 w. Compressed Air—July, 1902. No. 49672.

The Harris System of Pumping by Compressed Air, as Applied at the Deloro Mine. J. P. Kirkgaard. Illustrates and describes the displacement method applied. 2500 w. Compressed Air—July, 1902. No. 49670.

Conveying.

Rapid Transit of Material. Day Allen Willey. Illustrated description of various processes of the Brown Hoist, explaining their merits. 2000 w. Sci Am—July 5, 1902. No. 49268.

Friction.

Investigations of Adhesion and Sliding Friction (Untersuchungen über Adhäsion und Gleitende Reibung). Dr. Johann Basta. A mathematical discussion of the laws of friction in the light of recent experiments. 5,000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 5, 1902. No. 49435 B.

Power Plant.

Power Plant of the Frick Building, Pittsburg. Illustrates and describes the plant of this mammoth office-building of interest for its size, cost, magnificent finish and many mechanical problems that had to be solved. 4500 w. Engr, U S A—July 1, 1902. No. 49287.

The Mechanical Plant of a New York Office Building. Illustrated description of the installation in a 15-story building for heating, lighting and elevator service. 1500 w. Eng Rec—July 26, 1902. No. 49642.

The Mechanical Plant in the Rogers-Peet Building, New York. Illustrated description of a plant in an 8-story clothing house where a number of machines are driven electrically, and which has rather unusual accessories to the heating plant.

We supply copies of these articles. See page 975.

2200 w. Eng Rec—July 12, 1902. No. 49320.

The Mechanical Plant of the Chicago Tribune Building. Brief illustrated description of the building and its equipment, especially the mechanical features. 3600 w. Eng Rec—June 28, 1902. No. 49151.

The Mechanical Plant of the First National Bank, Uniontown, Pa. Illustrated description of the electric, heating, and elevator plant in an 11-story office structure, 10,100 sq. ft, in plan. 1700 w. Eng Rec—July 5, 1902. No. 49196.

Ropeways.

The Bleichert Aerial Ropeways. Illustrated detailed description of this system of wire ropeway and its working. 3000 w. Ir & Coal Trds Rev—July 11, 1902. No. 49535 A.

Variable-Speed.

The Delagneaux Extensible Pulley (La Poulie Extensible du M. Delagneaux). An illustrated description of a pulley whose diameter can be varied on the principle of the "Nuremberg shears" and so vary the speed transmitted. 600 w. Bull Soc d'Encouragement—June, 1902. No. 49478 G.

Worm Gearing.

Worm Gearing with High Efficiency (Schneckengetriebe mit Hohem Wirkungsgrade). N. Westberg. An illustrated description of worm gears made by the Oerlikon Company, principally for use with electrical machinery with account of tests showing high efficiency. 3000 w. Zeitschr d Ver Deutscher Ing—June 21, 1902. No. 49416 D.

SPECIAL MOTORS.

Alcohol Motors.

Competition and Exhibition of Alcohol Motors and Other Apparatus at Paris (Concours et Exposition de Moteurs et Appareils Utilisant l'Alcool Dénaturé). G. Coupan. Description of motors, automobiles and boats using alcohol, and account of competition held at Paris, 1902. Tables. 5000 w. Génie Civil—June 21, 1902. No. 49484 D.

Scientific Tests of Alcohol Motors. M. C. Krarup. Discusses the results of this year's tests in France, the necessity of guarding against corrosion, the defective combustion of all explosive motors, etc. 3300 w. Ir Age—July 24, 1902. No. 49592.

The International Competition of Alcohol Motors and Apparatus (Concours International des Moteurs et Appareils Utilisant l'Alcool Dénaturé). H. Guérin. An illustrated description of alcohol lamps and heaters, exhibited at Paris, 1902. 2400 w. Génie Civil—June 14, 1902. No. 49481 D.

The Status of Alcohol as a Power Source. Marius C. Krarup. Discusses the results of the trials in Germany and France, and the interest of the question in the United States. 3300 w. Ir Age—July 10, 1902. No. 49278.

See Mechanical Engineering, Special Motors.

Gas Engines.

Gas Engines at the Düsseldorf Exposition (Düsseldorfer Ausstellung 1902. Grosse Gasmotoren). C. Volk. Illustrated descriptions of large gas engines, particularly those for using blast-furnace gas. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 28, 1902. No. 49466 B.

Gas Engines at the Düsseldorf Exposition (Die Industrie und Gewerbeausstellung in Düsseldorf 1902. Die Gasmaschinen). R. Schöttler. A general review. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—June 14, 1902. No. 49413 D.

Gas Engine Piston Rings. James F. Hobart. Discusses the forms of rings, and how to make a nice wearing ring. 2200 w. Am Elect'n—July, 1902. No. 49255.

Gas Engines for Rolling Mill (Zur Frage der Gas-Walzenzugmaschine). An illustrated description of a 700-H. P. gas engine, using blast-furnace gases, for driving a train of rolls. 1500 w. Stahl u Eisen—July 15, 1902. No. 49451 D.

Large Gas Engines and the Gases Used by Them. Dugald Clerk. Read before the Gas Inst. (England.) Describes the construction and working of some large gas engines on the continent using blast furnace and other gases. Discussion follows. 10400 w. Gas Wld—June 14, 1902. No. 49062 A.

On Gas-Engine Temperatures. H. E. Wimperis. Gives some interesting deductions made from figures given in the last report of the Gas Engine Research Committee, with an explanation of the variability of the temperature throughout the mass of the gas. 3500 w. Engng—June 27, 1902. No. 49172 A.

700 Horse-Power Blast Furnace Gas Engine. Illustrated description of a double acting two-cycle gas engine of the Korting type, exhibited at the Düsseldorf Exhibition. 1100 w. Engng—June 27, 1902. No. 49176 A.

See Electrical Engineering, Miscellany.

Gasoline Engine.

Test of an Otto Gasoline Engine. E. C. Oliver. An illustrated account of tests made to obtain as accurately as possible a heat account or heat balance for the engine, and the temperatures within the cylinder at various points in the cycle. 1800 w. Am Mach—June 26, 1902. No. 49084.

The Determination of the Temperatures in a Gasoline Engine Cylinder. E. C. Oliver. Gives calculations made, explaining the data on which they are based. 1200 w. Am Mach—July 10, 1902. No. 49513.

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STEAM ENGINEERING.

Boilers.

A Four Hundred Horse-Power Horizontal Return Tubular Boiler. Illustrated detailed description. 1400 w. Power—July, 1902. No. 49138 C.

Boiler Bracing. W. H. Wakeman. Discusses methods of bracing, and the principle upon which the theory of bracing rests. 1200 w. Elec, N Y—July 16, 1902. Serial. 1st part. No. 49563.

Boiler with Three Large Fire Tubes (Der Dreiflammrohrkessel). Prof. L. Lewicki. An illustrated description of the Paucksch boiler, which has a third fire tube under the two main ones, with account of tests showing rapid heating and steam raising powers. 2500 w. Zeitschr d Ver Deutscher Ing—June 21, 1902. No. 49418 D.

Connecting Boilers to Steam Mains. W. E. Snyder. Gives sketches of a number of connections from boilers in actual service, with discussion of practice. 1700 w. Power—July, 1902. No. 49142 C.

Report of the Committee on Naval Boilers. Begins the publication of the report of the committee appointed by the Admiralty to investigate the subject of navy boilers. 4800 w. Engng—July 11, 1902. Serial. 1st part. No. 49540 A.

Stationary Boilers and their Accessories at the Paris Exposition of 1900 (Exposition Universelle de Paris 1900: Les Chaudieres à Vapeur Fixes et Leurs Accessoires). E. Masson. A general review. Serial. Part I. 1 plate. 6500 w. Rev Universelle des Mines—May, 1902. No. 49,694 H.

Steam Boilers at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902. Die Dampfkessel.) Illustrated descriptions of boilers and auxiliary apparatus, particularly those used for mining purposes. Serial. Part I. 1 plate. 1000 w. Glückauf—June 21, 1902. No. 49-456 B.

The Flaring of Boiler Tubes. Calls attention to precautions that should be taken and explains the best practice. 1200 w. Locomotive—May, 1902. No. 49135.

Chimneys.

Brick Factory Chimneys: Some Features of Their Construction. William Wallace Christie. Read at meeting of the New England Cotton Mfrs. Assn. Discusses points in design and construction, materials, etc. 2500 w. Engr, U S A—July 15, 1902. No. 49591.

Novel Method of Erecting a Steel Stack. Illustrates and describes a method employed in erecting a stack at West Albany, N. Y., by which the entire stack was raised at one time. 700 w. Ir Age—July 21, 1902. No. 49594.

Draft.

Mechanical Draft. F. R. Still. Discusses the factors that make the fan more economical than chimney draft, even when that is good. Ill. 11000 w. Jour W Soc of Engrs —June, 1902. No. 49296 D.

Ejector-Condenser.

The Theory of the Ejector-Condenser and Experiments with a New Type (Théorie des Ejecto-Condenseurs et Experiénces sur un Nouveau Type de ces Appareils). A. Rateau. Illustrated discussion of the theory of the Morton ejecto-condenser for steam engines, and account of experiments with a type designed by the author. 8500 w. Rev d Mécanique—June, 1902. No. 49477 E+F.

Emergencies.

Emergencies in the Boiler Room. R. A. Douglas. Calls atention to various emergencies and suggests what should be done to remedy the troubles. 4400 w. Am Elec'n —July, 1902. No. 49256.

Engines.

Dynamics of Reciprocating Engines. M. E. Cooley. Considers the forces to which the crank-pin is subjected, showing graphically the effect of the angularity of the connecting-rod and of the acceleration of the reciprocating parts. The discussion is confined to horizontal engines. 5200 w. Technic—1902. No. 49687 D.

500 Horse-Power Horizontal Compound Tandem Engine. Illustrations and brief description of an engine at the Düsseldorf Exhibition. 500 w. Engng—June 27, 1902. No. 49175 A.

700 Horse-Power Engines. Illustrations and account of the leading points in three sets of Corliss engines built recently in England. 1500 w. Engng—July 11, 1902. No. 49539 A.

The Correct Type of Engine for Large Generating Stations. A. A. Day. Read before the Incor. Munic. Elec. Assn. at Ismoton, England. Favors the low-speed type of engine, a horizontal compound or triple-expansion engine with direct-coupled generator between cranks, stating its advantages. Discussion. 7700 w. Elec Engr, Lond—July 11, 1902. No. 49582 A.

Firing.

Practical Hints on Firing. William Kavanagh. Illustrated discussion of different methods. 1700 w. Power—July, 1902. No. 49141 C.

Liquid Fuel.

Liquid Fuel for Steam Purposes. J. S. S. Brame. Considers the various methods of burning liquid fuel, estimations of the calorific value of different liquid fuels, cost, etc. 2800 w. Nature—June 19, 1902. No. 49112 A.

Texas Oil as a Steam Boiler Fuel. Gives results of experience in the use of Beaumont oil. 5200 w. Steam Engng—July 10, 1902. No. 49552.

We supply copies of these articles. See page 975.

Packing.

Observations on Metallic Packing. C. G. Robbins. A comparative study of the theories of fibrous and metallic packings and the reasons for the efficiency of the latter. Ill. 2000 w. Marine Engng—July, 1902. No. 49247 C.

Piston Heads and Packing Rings. J. H. Dunbar. Practical comments on the design and operation of steam engine pistons. Ill. 3000 w. Mach, N Y—July, 1902. No. 49251.

Scale.

Boiler Scale. William S. Bremner. Read before the Glasgow Branch of the Marine Engng. Assn. The treatment of the subject is almost altogether chemical. 3200 w. Engrs' Gaz—July, 1902. Serial. 1st part. No. 40334 A.

Shops.

Steam Engineering Department Shops, N. Y. Navy Yard. Illustrated description of the new shops which the writer thinks are the best built and best equipped shops for the repair and building of marine steam engines in the United States, if not in the world. 4000 w. Mach, N Y—July, 1902. No. 49250.

Smoke Prevention.

Smoke Consuming Furnaces (La Fumivorité des Foyers). V. Belugou. An illustrated description of the Sabourain smoke-consuming furnace and account of experience with it at the shops of the pneumatic tube company of Paris. 1200 w. Génie Civil—June 14, 1902. No. 49482 D.

See Gas Works Engineering.

Speed Regulation.

Adjustment and Regulation of the Rites Governor. F. M. Rites. Directions regarding its adjustment and regulation. 3500 w. Power—July, 1902. No. 49139 C.

Engine Speeds for Direct-Connected Alternators. Edgar Knowlton. Discusses the influence of speed on the amount of flywheel effect required. 1300 w. Elec Wld & Engr—July 26, 1902. No. 49652.

Spring Governor (Leistungs-Federregler). J. Stumpf. An illustrated description of a steam engine governor with a wide range, which will act both as a regulator and as a safety device. 2000 w. Zeitschr d Ver Deutscher Ing—June 14, 1902. No. 49414 D.

The Weight of Flywheels for Alternating Current Units. J. Begtrup. Gives method of determining the weight, illustrating by examples, and giving displacement curves of various types of engine. 1800 w. Am Mach—July 10, 1902. No. 49514.

Steam.

Rapid Steam Raising. G. W. Worrall. Discusses the Rapid steam-raising qualities of a boiler, and the methods of heating, fuel, etc. 1800 w. Horseless Age—July 9, 1902. No. 49503.

Steam. A reply to an article published in this paper on May 30. States existing theories of the nature of steam and examines observed phenomena. 4200 w. Engr, Lond—June 20, 1902. No. 49125 A.

Steam Plant.

Power Plant of the Champion Coated Paper Co., Hamilton, O. Fred W. Ballard. Illustrates and describes a plant of about 4000 h. p., in which almost complete use will be made of the exhaust steam. 4200 w. Engr, U S A—July 15, 1902. No. 49589.

Steam Turbines.

Steam Turbines. S. E. Fedden. Read before the Incor. Munic. Elec. Assn. at Islington, England. Calls attention to some of the advantages of the steam turbine when running under the conditions for working in a power station, and gives information of interest. 2000 w. Elec Engr, Lond—July 11, 1902. No. 49581 A.

The Steam Turbine at Hartford. Illustrates and describes briefly this turbine, the largest yet installed in the United States. 1000 w. Power—July, 1902. No. 49137 C.

Stoking.

The Economy of Mechanical Stoking. W. W. Christie. The second and concluding paper gives actual comparisons between machine and hand firing gathered from numerous tests. 3000 w. Engineering Magazine—August, 1902. No. 49707 B.

Stopping Devices.

Engine Safety Stopping Devices. James F. Hobart. Illustrated description of various forms in use. 1300 w. Am Elect'n—July, 1902. No. 49257.

Valves.

A Style of Valve Difficult to Set. H. H. Kelley. Concerning the piston valve used for high pressures, giving illustrations of various types, and suggestions for their adjustment. 2000 w. Engr, U S A—June 16, 1902. No. 49073.

Water Level.

The Water Level in a Battery of Boilers. W. H. Wakeman. Concerning the proper arrangement of feed pipes. Ill. 1100 w. Steam Engng—July, 1902. No. 49553.

MISCELLANY.

Address.

Master Mechanics' Association. Extract from the able address of President Waitt, discussing recent motive power improvements, the handling of traffic, etc. 2000 w. Am Engr & R R Jour—July, 1902. No. 49241 C.

Aeronautics.

The "Mellin" Air Ship. Illustrations with brief description. 500 w. Auto Jour—July 10, 1902. No. 49623 A.

We supply copies of these articles. See page 975.

By-Products.

The Census Bulletin on the Utilization of Wastes and By-Products. Reviews certain features of a paper by Henry C. Kittredge, criticizing some of the statements. 2000 w. Eng News—July 24, 1902. No. 49660.

Economy.

Comparative Economy of Structures. Gives problems showing methods of determining the relative economy of different structures or machines for accomplishing the same ends. 2200 w. Technic—1902. No. 49688 D.

Gyrostatic Action.

Gyrostatic Action and Its Bearing on Certain Points of Enginering Design. W. R. Kelsey. An investigation of the nature and magnitude of the forces called into action when the plane of rotation of a revolving mass is turned through any angle. Ill. 1200 w. Elec Engr, Lond—July 18, 1902. No. 49617 A.

Heating.

Central Station Heating (Fernheizungen). Prof. Rietschel. Paper before the Berlin Section of the Ver. deutsch. Ing. on long distance steam heating in general, with a particular description of the great Dresden plant. 6000 w. Zeitschr d Ver Deutscher Ing—June 28, 1902. No. 49419 D.

Heating and Ventilating a Residence with Steam. Illustrated detailed description of the system used in a large four-story residence in Middletown, N. Y. It provides direct, semi-direct and indirect radiation, and the open fireplaces are arranged to create an outflow or exhaust current of air. 2500 w. Met Work—July 5, 1902. No. 49198.

Pipe Sizes for Hot Water Heating. Charles L. Hubbard. An illustrated article considering the conditions that determine the size, and the method of computing the effect of each. 2800 w. Engr, U S A—July 1, 1902. No. 49288.

Refrigeration.

An English Municipal Ice and Cold Storage Plant. Brief description of the plant of the corporation of Wolverhampton. 1000 w. Eng Rec—July 26, 1902. No. 49643.

Commercial Methods of Cooling. Henry H. Kelley. Illustrated descriptions of various methods of producing low temperatures. 1300 w. Engr, U S A—July 15, 1902. No. 49500.

How to Buy or Build an Ice-Making Tank. William Nottberg. An illustrated article giving the writer's idea of the different insulations used in the construction of such tanks. 2200 w. Engr, U S A—July 1, 1902. No. 49289.

The U. S. Refrigerating Plant at Manila, P. I. Illustrated description of a 2-story plant 245 ft. square, built by the War Department for cold storage and ice making. 3000 w. Eng Rec—July 5, 1902. No. 49191.

Ventilation.

Ventilating and Heating the Rochester Athenaeum and Mechanics' Institute. Illustrated description of a plant embracing both hot-blast warming and ventilation, and direct and indirect steam heating, the air supply being passed through moist coke as a filter. 2200 w. Eng Rec—July 19, 1902. No. 49561.

Wire Glass.

Wire Glass (Conférence sur le Verre Armé). L. Appert. A well illustrated account of the manufacture and applications of glass with an internal wire network, with abstracts of the principal patents. 10000 w. Bull Soc d'Encouragement—June, 1902. No. 49479 G.

MINING AND METALLURGY

COAL AND COKE.

Africa.

Coal Supply of the Rand. From the *African Review*. Shows the areas from which coal may be drawn for use in the mines. 1000 w. Ir & Coal Trds Rev—July 4, 1902. No. 49362 A.

Anthracite Mines.

Anthracite Coal Mines and Mining. Rosamond D. Rhone. An illustrated article describing the mines, their ventilation, mining accidents, etc., the methods of mining and preparing the coal for market are also considered and related matters of interest. 7000 w. Rev of Revs—July, 1902. No. 49327 C.

Anthracite Mining.

See Industrial Economy.

Briquetting.

The Briquetting of Brown Coal (Die Entstehung des Braunkohlenbriketts). C. Kegel. A discussion of the physical and chemical properties of brown coal and their influence on processes of briquetting. 2000 w. Glückauf—July 5, 1902. No. 49461 B.

China.

The Kaiping Coal Mines and Coal Field, Chihle Province, North China. Herbert C. Hoover. Read before the Inst. of Min. & Met. Gives the location, history, geology, character of the coal, coking qual-

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ities, mines and methods, and general information. 2200 w. Col Guard—June 25, 1902. No. 49170 A.

Coal Cutting.

Experiments with Coal-Cutting Machinery in the Ruhr District, Germany (Versuche mit Schrämmaschinen im Ruhrkohlenbecken). Hr. Kier. A discussion of coal cutting by machinery and illustrated descriptions of various machines. 3 plates. 7500 w. Glückauf—July 5, 1902. No. 49460 B.

The Application of Coal-Cutting Machines to Deep Mining. W. E. Garforth. Read before the Midland Inst. of Min., Civ., and Mech. Engrs. An illustrated article claiming that the difficulties experienced in deep mining may be overcome, and the coal worked economically. 2800 w Col Guard—July 1, 1902. Serial. 1st part. No. 49361 A.

See Electrical Engineering, Power Applications.

Coal Trade.

United States Coal Trade. Frederick E. Saward. Gives information concerning the important coal-producing districts. 2200 w. Loc Engng—July, 1902. No. 49201 C.

Coke.

Notes on the Industrial Use of Gas Works Coke. Alexander Lencouchez. Read at meeting of the Société Technique du Gaz en France. Discusses how to burn gas coke, the heating of water and raising of steam, making producer gas, etc., etc. Ill. 3500 w. Gas Wld—July 12, 1902. No. 49525 A.

Depreciation.

Depreciation of Coal and Coke by Shipment. Report submitted at the International Navigation Congress, Düsseldorf. 3500 w. Engng—July 18, 1902. No. 49630 A.

Disaster.

The Fernie Colliery Disaster. C. H. Gibbons. An account of a disastrous explosion at Coal Creek, British Columbia, costing 151 lives. Ill., 1800 w. B. C. Min Rec—July, 1902. No. 49520 B.

Düsseldorf Exposition.

Ore Concentration, Coal Preparation Briquetting and Coke Manufacture with the Winning of By-Products (Der Bergbau auf der Düsseldorfer Ausstellung. 1902. Aufbereitung, Brikettierung und Kokereibetrieb mit Einschluss der Gewinnung von Nebenprodukten). Hr. Wendt. A general illustrated review of the exhibits in these departments of mining and metallurgy. 8 plates. 12000 w. Glückauf—July 12, 1902. No. 49462 B.

Nova Scotia.

On the Possible Occurrence of a Coal Area Beneath the Neo-Carboniferous or Permian Strata of Pictou County, Nova Scotia. Dr. H. M. Ami. An illustrated explanation of the geology of the district and reasons for supposing a new coal-field may be found. 2500 w. Can Min Rev—June 30, 1902. No. 49223 B.

Peat Fuel.

The Manufacture of Peat Fuel by the Aid of Electricity. Illustrates and describes the process invented by P. Jebsen, of Norway, in which the electric current is used to carbonize the dried peat in retorts of special design. 1000 w. Engr, Lond—June 27, 1902. No. 49182 A.,

Queensland.

Queensland Coal Fields. Information from the *Imperial Institute Journal* concerning the output and working of the various districts. 2500 w. Col Guard—June 25, 1902. No. 49171 A.

Thick Seam.

A Method of Working. William Charlton. Read before the So. Staffordshire and E. Worcestershire Inst. of Min. Engrs., England. Illustrates and describes the method of working the thick coal seam in two sections, at the New Hawne Colliery, Staffordshire, England. 1500 w. Mines & Min—July, 1902. No. 49310 C.

COPPER.

Alaska.

The Copper Deposits of the White, Tanana, and Copper River Regions of Alaska. Alfred H. Brooks. From the reports of the U. S. Geol. Survey, describing these regions and giving maps, and general information. 1200 w. Eng & Min Jour—July 5, 1902. No. 49234.

British Columbia.

The Ore Deposits of the Boundary (Creek) District, B. C. R. W. Brock. Describes the geology of the region very briefly, discussing the low-grade copper-bearing sulphide deposits, the oxydized copper veins, and the small gold and silver bearing quartz veins. 5500 w. Can Min Rev—June 30, 1902. No. 49222 B.

Deposits.

Recent Development of Southern Copper Deposits. Walter Harvey Weed. Information concerning the Ducktown district, the Virginia copper belt, and the Gold Hill district. 2000 w. Eng & Min Jour—July 19, 1902. No. 49577.

Queensland.

Copper Deposits of the Mount Perry District. Allan Gibb. Notes on these copper-bearing lodes, describing their occurrence and working. Ill. 5500 w. Q Gov Min Jour—May 15, 1902. No. 49390 C.

GOLD AND SILVER.

Africa.

West African Gold Mining and the Con-

cessions Industry. John Geo. Leigh. A review of conditions on the Gold Coast, giving the true state of affairs on this over-exploited region. 4000 w. Engineering Magazine—August, 1902. No. 49702 B.

Cupelling.

A New Form of Cupel. Joseph Voyle. Describes using a kaolin slab for the cupelling and estimation of minute beads of gold and silver. 900 w. Min & Sci Pr—July 19, 1902. No. 40675.

Drift Mine.

The Kimble Drift Mine, El Dorado County, Col. George W. Kimble. Describes the mine, mode of working, timbering, ventilation, milling, etc. 1700 w. Min & Sci Pr—July 12, 1902. No. 49562.

Dry Crushing.

The Dry Crushing of Ore. Abstract of an important paper by Philip Argall, read at London, before the Inst. of Min. & Met. Discusses sampling and dry crushing referring more especially to the treatment of the telluride ores of Cripple Creek, Colorado. 4200 w. Eng & Min Jour—July 5, 1902. Serial. 1st part. No. 49232.

Extraction.

Extraction of Gold by Chlorobromuration (C. Grollet's Process). The process consists in the simultaneous employment of chlorine and bromine, with the aid of pressure in certain conditions. 2300 w. Min & Sci Pr—July 19, 1902. Serial. 1st part. No. 49674.

Ironsands.

Auriferous Ironsands of New Zealand. Information concerning these deposits on the east and west coats. 4800 w. N. Z. Mines Rec—May 16, 1902. No. 49113 B.

Japan.

Telluride Ore in Japan. E. W. Nardin. A short illustrated account of the Nojiri mine where the writer discovered tellurides of gold. 1200 w. Aust Min Stand—May 22, 1902. No. 49566 B.

Oil Furnaces.

Notes on Oil Furnaces for Assaying and Melting. Charles Brent. Illustrated description of furnaces used in the assay office and melting room, which may be constructed at small cost, and are in many ways more convenient than furnaces of the old type burning solid fuel. 2000 w. Can Min Rev—June 30, 1902. No. 49221 B.

Oregon.

Bohemia Mining District of Western Oregon. James P. Kimball. Map, and account of this district with statement of values of veinings as shown by present developments. 2000w. Eng & Min Jour—June 28, 1902. No. 49106.

Production.

The World's Production of Gold and Silver During 1901. Joseph Struthers. Tables and diagrammatic charts of the output of each metal in the principal countries of the world, showing recent progress. Explanatory notes. 2000 w. Eng and Min Jour—July 5, 1902. No. 49233.

Recovery.

Saving Gold from Black Sand. Explains the difficulty met in solving this problem, and considers the cyanide process the solution, precipitating the gold by the use of a current of electricity. 1200 w. Min & Sci Pr—June 28, 1902. No. 49216.

Slimes.

A New Treatment of the Slime Problem in Cyaniding Talcose Ores. Morrill D. Stackpole. A detailed description of the method to be employed at the Sunshine Mill, Utah. Ill. 1500 w. Eng & Min Jour—July 12, 1902. No. 49392.

Smelters.

British Columbia Smelters. E. Jacobs. Shows the gradual increase in the treatment capacity, and reports the smelter betterments. 1500 w. Eng & Min Jour—July 5, 1902. No. 49235.

The New Plant of the American Smelting and Refining Company at Murray, Utah. Brief description. 1200 w. Eng & Min Jour—June 28, 1902. No. 49107.

Tests.

Tests for Gold and Silver in Shales from Western Kansas. Waldemar Lindgren. Abstract of a bulletin of the U. S. Geol. Survey. Gives an account of the investigations, methods of testing, results, etc. 3000 w. Eng & Min Jour—July 26, 1902. No. 49646.

Transvaal.

The Gold Mines of the Transvaal. Comments on the development of these mines in South Africa, the future outlook, their contribution to mining knowledge, etc. 1600 w. Eng & Min Jour—July 5, 1902. No. 49230.

Veins.

Origin and Relations of the Auriferous Veins of Algoma (Western Ontario). W. O. Crosby. The writer's observations in the Michipicoten District are presented, with a general summary of Dr. A. P. Coleman's observations and conclusions, and a comparison of the theories of vein formation as applied to this field. Ill. 6800 w. Tech Qr—June, 1902. No. 49324 E.

Washington.

Notes on the Republic District, Washington, with Special Reference to the Metallurgy of Its Ores. J. C. Ralston. An account of this region which has produced about $1,400,000 in gold and silver, the sil-

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ver being a small percentage. Ill. 4800 w. Eng & Min Jour—July 19, 1902. No. 49576.

Western Australia.

Western Australia: Its Progress and Resources. H. W. Venn. Contains information concerning the gold industry, and other mineral resources. Also brief discussion. 10000 w. Jour Soc of Arts—June 20, 1902. No. 49111 A.

IRON AND STEEL.

Analysis.

Contributions to the Analysis of Iron (Beiträge zu der Analyse des Eisens). Felix Bischoff. A discussion of the best methods for securing uniformity in the analysis of iron and steel, with diagrams and tables. Serial. 2 parts. 1 plate. 8000 w. Stahl u Eisen—July 1, 15, 1902. No. 49450 each D.

Australia.

Iron in Australia. W. H. Harrison. Reviews the history of past attempts at iron manufacture in Australia, with the conclusion that the Australian ores can be reduced to fibrous or wrought iron more readily than to cast or pig iron. 1600 w. Aust Min Stand—May 29, 1902. No. 49567 B.

Calcium and Magnesium.

Calcium and Magnesium in Iron (Ueber einen Gehalt des Eisens an Calcium und Magnesium). Prof. A. Ledebur. An account of experiments showing that calcium and magnesium can combine with iron only in the electric furnace and in the presence of silicon. 1500 w. Stahl u Eisen—July 1, 1902. No. 49449 D.

Concentration.

The "Humboldt" Company's Pavilion for Ore Treatment and Concentration at the Düsseldorf Exposition (Düsseldorfer Ausstellung, 1902. Pavillon für Erzaufbereitung der Maschinenbauanstalt "Humboldt" in Kalk). An illustrated description of ore-treating apparatus and particularly of magnetic separators for iron ore. 2 plates. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 14, 1902. No. 49463 B.

Gas Analysis.

See Gas Works Engineering.

Germany.

See Marine Engineering.

Gutehoffnungs Works.

The Gutehoffnungs Iron and Steel Works (Die Werke der Gutehoffnungshütte.) A very well illustrated historical and descriptive account of these old and great works at Oberhausen, in the Rhineland. Serial. Part I. 2000 w. Zeitschr d Ver Deutscher Ing—July 12, 1902. No. 49423 D.

Lake Superior.

The Lake Superior Iron Ore Mines. L. Douglass Anderson. A description of the important mines of this region, methods of mining, development, discovery, etc. Ill. 6000 w. Technic—1902. No. 44690 D.

Malleable Iron.

The Manufacturing of Malleable Iron. Joseph V. Woodworth. An account of methods employed at Hoosick Falls, N. Y., in a large shop for the manufacture of machine parts. 1500 w. Am Mach—July 17,1902. No. 49598.

Manufacture.

Manufacture of Iron and Steel. R. R. Neild. Read before the Canadian Ry. Club. Gives a brief outline of this important industry. 2500 w. Can Engr—July, 1902. No. 49212.

Melting.

A Queer Phenomenon in Melting. G. P. Blackiston. Gives evidence supporting the statement that iron and steel melt from the inside, the outside being the last to be converted to a liquid state. Ill. 700 w. Ir Age—July 24, 1902. No. 49593.

New Zealand.

Iron Ores and Sands of New Zealand. Sir James Hector. Brief description of the ores and statement of where they are found. 1000 w. N Z Mines Rec—May 16, 1902. No. 49115 B.

Open-Hearth.

American Open-Hearth Steel Plants (Amerikanische Siemens-Martin-Anlagen). Hermann Jllies. A well illustrated account of the Carnegie plants at Homestead and Duquesne, the Pencoyd and the Sharon plants. Two parts. Three plates. 2000 w. Stahl u Eisen—June 15. July 1, 1902. No. 49445 each D.

A Special Open-Hearth Steel Process (Eine Besondere Art des Erzprocesses im Martinofen). W. Schmidhammer. A description, with tables and diagrams, of charges for open-hearth furnaces consisting principally of pig iron and ore with no scrap, as used in the Ural and elsewhere. 1500 w. Stahl u Eisen—June 15, 1902. No. 49446 D.

Rails.

The Structure and Finishing Temperature of Steel Rails. Albert Sauveur. Read at meeting of Am. Soc. for Testing Materials. Discussion of the treatment of steel, with description and criticism of the Kennedy-Morrison rail finishing process. 2200 w. Ir Trd Rev—June 19, 1902. No. 49097.

MINING.

Discipline.

Discipline and Danger in Mines. R. W. Raymond. A discussion of the reckless-

ness and wastefulness of miners, especially coal miners, 2400 w. Eng & Min Jour—July 26, 1902. No. 49644.

Drilling.

Rock Drilling Contest at Idaho Springs, Colorado. An illustrated account of contest with air drills, giving tabulated record. 1200 w. Min Rept—July 17, 1902. No. 49584.

Electric Haulage.

See Electrical Engineering, Power Applications.

Explosives.

Mining Explosives. James Tonge, Jr. Gives the theory of an explosion, with a description and classification of the explosives used in the coal mines of Great Britain. 3500 w. Mines & Min—July, 1902. No. 49306 C.

Faults.

Certain Conditions in Veins and Faults in Butte, Mont. William Braden. Briefly outlines the geology of this district, noting some characteristic features of a region containing one of the most wonderful vein systems known. Ill. 2000 w. Can Min Rev—June 31, 1902. No. 49219 B.

Faults in Metal Mines. Prof. Arthur Lakes. Illustrated description of the different types and their various manifestations, showing their effect upon ore deposition. 1700 w. Mines & Min—July, 1902. No. 49307 C.

Firedamp.

The Relation Between Firedamp Explosions and the Height of the Barometer in the Dortmund District, Germany, in 1901 (Die Schlagwetterexplosionen in Oberbergamtsbezirk Dortmund mit Beziehung auf den Barometerstand im Jahre, 1901). A record of observations, with tables and curves, and discussion. 1 plate. 2000 w. Glückauf—June 28, 1902. No. 49459 B.

France.

Government Report on French Mines. Information from the official report on the working of mines in France since July 1, 1899. The present article deals with the general conditions of the industry. 1500 w. Col Guard—July 11, 1902. Serial. 1st part. No. 49536 A.

Mining in France. A résumé of information from a recent report of the Minister of Public Works regarding the coal, iron and other mining industries. 1700 w. U. S Cons Repts, No. 1386—July 8, 1902. No. 49190 D.

Geological Survey.

The Geological Survey and the Western Miner. T. A. Rickard. On the value of the work of the survey to the miner, and the practical value of the work done, urging that it be made more timely. 1400 w. Eng & Min Jour—July 5, 1902. No. 49231.

Haulage.

Compressed-Air Haulage. Robert Peele. A comparison of the several forms of motor haulage, stating the particular advantages of compressed air for mine work. 4000 w. Mines & Min—July 1, 1902. No. 49312 C.

Different Methods of Hauling Ore at Bingham, Utah. W. P. Hardesty. Brief illustrated descriptions of recent improvements in transporation from the mines to the railroad. 3000 w. Eng News—July 24, 1902. No. 49659.

Hoisting Machines.

See Electrical Engineering, Power Applications.

Hoisting Ropes.

Hoisting Wire Rope Statistics for the Breslau District, Silesia, in 1901 (Statistik der Schachtförderseile im Oberbergamtsbezirke Breslau im Jahre 1901). Abstract from official reports on round and flat, iron and steel wire ropes, their life and breakage. 800 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 14, 1902. No. 49-465 B.

Methods.

Mining Methods in America and Europe. Impressions of Capt. G. A. Richard from a recent tour through Canada, America, Great Britain and the Continent in the interest of a gold-mining company. 2300 w. N Z Mines Rec—June 16, 1902. No. 49-524 B.

Mine Draining.

See Electrical Engineering, Power Applications.

Ore Handling.

New Ore Handling Machinery. Waldon Fawcett. Illustrates and describes new devices for use on docks and in blast furnaces. 1600 w. Am Mfr—July 17, 1902. No. 49569.

Organization.

Commercial Mine Organization. Charles V. Jenkins. Shows the advantages of a systematic organization of the mine and office force, giving suggestions for bookkeeping. 5000 w. Mines and Min—July, 1902. No. 49305 C.

Pumping.

See Electrical Engineering, Power Applications.

Safety Lamps.

Safety Lamps and Colliery Explosions. James Ashworth. Discusses the safety value of various lamps, giving illustrations. 3300 w. Can Min Rev—June 30, 1902. No. 49218 B.

Shaft Sinking.

Description of Primary Operations and Temporary Plant Required for a Sinking Pit. Harold T. Foster. Describes the or-

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der in which the operations of setting out and erecting the surface arrangements should be approached, and the progress of the undertaking. Ill. 1700 w. Ir & Coal Trds Rev—July 4, 1902. No. 49363 A.

Shaft Sinking (Schachtabteufen). A review of compressed air, freezing and other recent processes. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 14, 1902. No. 49464 B.

Sinking a Deep Coal Shaft at Atchison, Kansas. William R. Crane. Describes the sinking plant, and method of sinking. 2000 w. Eng & Min Jour—July 26, 1902. No. 49645.

The Pattberg Boring Process and Its Application to Shaft Sinking (Das Stossbohrverfahren von Pattberg und seine Anwendung beim Abteufen der Schächte der Zeche Rheinpreussen in Lockerem Gebirge). L. Hoffmann. An illustrated description of a method of sinking shafts in soft ground, in which a frame, armed with a boring edge, loosens the soil, water is forced in and the mud is removed by a pump. 1 plate. 2000 w. Glückauf, June 14, 1902. No. 49545 B.

Ventilation.

Mine Ventilation Apparatus at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung, 1902. Wetterführung unter Besonderer Berücksichtigung der Ventilatoren). Hr. Stein. An illustrated description of blowers, sprayers and other ventilating apparatus. 3 plates. 2500. Glückauf—June 14, 1902. No. 49453 B.

The Advantages of Small Fans for Mine Ventilation. Considers the tendency to ventilate workings by means of one or more small quick-running fans, showing the method to be efficient and economical. 2000 w. Col Guard—June 20, 1902. No. 49124 A.

Winding Engine.

Horizontal Twin-Tandem Winding Engine. Illustrated detailed description of a powerful engine exhibited at the Düsseldorf Exhibition. 1000 w. Engng—June 20, 1902. No. 49130 A.

MISCELLANY.

Asbestos.

Asbestos and Its Production in Canada. W. Mollmann. Information concerning the localities, quality, methods of mining or quarrying, and the importance to Canada of the industry. 2500 w. Can Min Rev—June 30, 1902. No. 49220 B.

Bosnia-Herzegovina.

Mining and Metallurgy in Bosnia and Herzegovina for 1901 (Das Berg- und Hüttenwesen in Bosnien und der Hercegovina im Jahre 1901). Statistics, with tables. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 5, 1902. No. 49468 B.

Japan.

The Mineral Products of Japan. Information concerning gold, coal, iron, copper, etc. 1000 w. Jour Soc of Arts—July 18, 1902. No. 49616 A.

Joplin, Mo.

Zinc and Lead in the Joplin Field. Albert Phenis. On the development of this district, considering that many years will be required to develop the proved territory. 2200 w. Mfrs Rec—July 10, 1902. No. 49267.

Lithographic Stone.

The Lithographic Stone Deposits of Eastern Kentucky. E. O. Ulrich. Map, with description of the deposits and statement of their value. 1800 w. Eng & Min Jour—June 28, 1902. No. 49108.

Mica.

The Canadian Mica Industry (L'Industrie du Mica au Canada). A. Ladureau. A brief review of the mica industry in general and that of Canada in particular. 800 w. Génie Civil—June 14, 1902. No. 49483 D.

Petroleum.

The Geology of the Roumanian Oil Regions (Geologische Verhältnisse der Erdölzonen in Rumänien). Prof. Mrazek. Abstract of a government report. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 5, 1902. No. 49467 B.

The Origin of Petroleum. Julius Ohly. Gives different theories which have been advanced and the circumstances for and against them. 3000 w. Mines & Min—July, 1902. No. 49304 C.

Platinum.

Micro-Crystalline Structure of Platinum. Thomas Andrews. Read before the Royal Soc. An interesting illustrated study. 1000 w. Engng—June 27, 1902. No. 49178 A.

Quarries.

The Granite Quarries of Yr Eifl. Illustrates and describes these interesting quarries in Wales. 2600 w. Quarry—July, 1902. No. 49332 A.

Salt Deposits.

The Formation and Geology of the Salt Deposits. F. O. Jones. An explanation of their formation and account of the causes that contributed. Ill. 2200 w. Sci Am—July 26, 1902. No. 49681.

Sapphires.

The Sapphire Fields of Anakie. B. Dunstan. Locates and describes these sapphire fields in Central Queensland. Ill. 11800 w. Q Gov Min Jour—May 15, 1902. Serial. 1st part. No. 49391 C.

Silesia.

Mining and Metallurgy in Upper Silesia for 1901 (Statistik der Oberschlesischen

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Berg- und Hüttenwerke für das Jahr 1901). Statistics, with tables, of iron and steel, coal and coke, zinc, lead, silver and sulphur. Two parts. 2400 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 5 and 12, 1902. No. 49470 each B.

Titanium.

Production of Titanium Ores. W. O. Snelling. Information concerning the deposits, their uses, methods of preparing titanium alloys, etc. 2600 w. Am Mfr—July 24, 1902. No. 49682.

Transvaal.

The Geology of the Transvaal, Particularly of the Ore Beds (Die Geologie der Südafrikanischen Republik Transvaal unter Besonderer Berücksichtigung der Lagerstätten). Karl A. Redlich. Review of an article by Molengraf in *Bulletin de la Société Géol. de France*, on the gold reefs and other geological features. 1400 w. Oesterr Zeitschr f Berg u Hüttenwesen. July 12, 1802. No. 49469 B.

Volcanoes.

Volcanoes. Prof. Arthur Lakes. An illustrated article considering the manner of their eruption, their effect upon the deposition of minerals, and their relation to the mining fields in Colorado. 3000 w. Mines & Min—July, 1902. No. 49309 C.

Zinc Smelting.

The Picard and Sulman Method of Zinc Smelting. Brief account of this method with comments. 1200 w. Eng & Min Jour—July 26, 1902. No. 49647.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Railroad Accidents for the Last Quarter of 1901. A summary from the recently issued report of the Interstate Commerce Commission. 1700 w. R R Gaz—June 27, 1902. No. 49157.

Coal Carrying.

The Anthracite-Carrying Railways. H. T. Newcomb. A statement of the conditions connected with anthracite transportation, and the difficulties arising. 2000 w. Rev of Revs—July, 1902. No. 49329 C.

Employees.

The Superintendent, the Conductor and the Engineman. B. B. Adams. Discusses the relation of these men to the collision record. 7000 w. R. R. Gaz—July 18, 1902. No. 49608.

Fast Runs.

New York to Chicago in Twenty Hours. Information concerning runs made by the new twenty-hour trains between New York and Chicago. Ill. 700 w. Ry Age—July 25, 1902. No. 49683.

Resistance.

Train Resistance. A. H. Armstrong. Considers the question of train friction, comparing the data from different tests. 2500 w. St Ry Jour—July 5, 1902. No. 49262 D.

Train Resistance Formulæ. John Balch Blood. A discussion of the formulæ deduced by Mr. Davis, based on a series of tests on the Buffalo & Lockport Ry. 2000 w. St Ry Jour—July 5, 1902. No. 49263 D.

Train Speeds.

Train Speeds in Germany and America. Extracts from article by George C. Tunell, in the June number of the *Journal of Political Economy*. Discusses statements made in paper by W. Schulze, and the comparisons made. 2700 w. Ry Age—July 18, 1902. No. 49568.

MOTIVE POWER AND EQUIPMENT.

Car Lighting.

Car Lighting. L. T. Canfield. Topical discussion at the Mas. Car Bldrs. Assn. Discusses the Pintsch light, and the electric light principally. 2000 w. R R Gaz—July 11, 1902. No. 49354.

The Lighting of Railway Cars (L'Eclairage des Voitures de Chemins de Fer). J. Carlier. A comprehensive, illustrated review of all methods of lighting cars by candles, oil, gas, acetylene, electricity, etc. Serial. Part 1. 7000 w. Rev Universelles des Mines—May, 1902. No. 49695 H.

The Electric Lighting of Trains (Eclairage Electrique des Trains). M. Jacquin. A comprehensive illustrated account of the principal systems of car lighting by electricity. Two parts. 2000 w. Bull Soc Internationale des Electriciens—May and June, 1902. No. 49493 each E.

Cars.

Test of 100,000 Lbs. Capacity Steel Dump Cars for Colorado Fuel & Iron Co. Illustration, with report of loading tests. 600 w. Ry & Engng Rev—July 12, 1902. No. 49519.

Compressed Air.

Compressed Air Locomotives. Illustrated description of locomotives for yard service in the Invalides Station in Paris. 1200 w. Sci Am Sup—June 28, 1902. No. 49095.

Continental Practice.

Features of European Locomotive Construction. Charles R. King. Mr. King's

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concluding paper discusses the engines of Switzerland, Saxony, Russian and northern Europe generally. 4500 w. Engineering Magazine—August, 1902. No. 49703 B.

Economizer.

An Improved Fuel Economizer and Smoke Consumer. Illustrated detailed description, with results of tests of an improved device which is to be applied to all new passenger engines on the N. Y. C. & H. R. R. R. and also on other roads. 2000 w. Ry & Engng Rev—June 28, 1902. No. 49102.

Electric Traction.

Electric Problems of Main-Line Railway Traction. Charles T. Child. A thoughtful examination of the fundamental conditions of the problem, showing the limitations of modern electric motors for railway use. 2500 w. Engineering Magazine—August, 1902. No. 49704 B.

The Relative Efficiency of Electric and Steam Locomotives (Die Leistungsfähigkeit der durch den Elektrischen Strom und der durch Dampfkraft Betriebenen Lokomotiven). Hr. Beyer. A general discussion of electric vs. steam traction on standard railways. 1800 w. Glasers Annalen—July 1, 1902. No. 49427 D.

Electric Traction in Its Relation to Existing Railways. J. W. Jacomb-Hood. Read before the London & Southwestern Ry. Debating Soc. A discussion of the subject from the point of view of a practical railway operator. Considers the possible advantages of electricity over steam, service, etc. 3700 w. Transport—July 11, 1902. Serial. 1st part. No. 49523 A.

Feed-Water Heater.

M. N. Forney's Feed-Water Heater for Locomotives. Illustrated description from advance sheets of a pamphlet by Mr. Forney. 4700 w. R R Gaz—June 27, 1902. No. 49155.

Fire Prevention.

Railway Fire Prevention. Major Fox. Considers the most important points relating to fire dangers and fire appliances in their relation to railway companies. 2200 w. Transport—July 4, 1902. No. 49338 A.

Friction Tests.

Tests of the Friction of Side Bearings and Center Plates for Freight Cars. Abstract of a report of a special committee of the Mass. Car Bldrs. Assn., giving account of tests, with results and conclusions. 4000 w. Eng News—July 10, 1902. No. 49388.

Frozen Pipes.

Frozen Train Pipes, Their Cause and Prevention. Parts of the discussion of the second report presented at the Air-Brake Convention at Pittsburg. 3500 w. R R Gaz—July 18, 1902. No. 49611.

Locomotive Repairs.

Crosshead and Piston Rod Connection. Roger Atkinson. The causes of failures are discussed, and the methods of overcoming the difficulties. 1000 w. R R Gaz—July 18, 1902. No. 49609.

Locomotives.

Consolidation Freight Locomotive for the New York, Chicago and St. Louis Railroad. Illustrated description. 600 w. Ry Mas Mech—July, 1902. No. 49549.

Eight-Wheeled Six-Coupled Tank Engine. Illustrations with brief description of engines for the Bombay, Baroda and Central India Ry. to meet unusual conditions of service. 300 w. Engr, Lond—June 27, 1902. No. 49181 A.

European Railway Jottings. Charles Rous-Marten. Discusses the growing popularity of ten-wheel passenger engines, illustrating a new engine, and considering a decapod suburban engine and powerful French engines. 1600 w. Loc Engng—July, 1902. No. 49200 C.

Express Engine, Great Central Railway. Illustration, with description of an engine for through express passenger traffic. 800 w. Engr, Lond—July 4, 1902. No. 49379 A.

Four-Cylinder Compound Locomotives with Goelsdorf Steam Distribution System (Nouvelles Locomotives Compound à Quatre Cylindres à Dispositif de Démarrage Système Goelsdorf). Illustrated description of Atlantic type locomitives for the Austrian government railways. 2500 w. Génie Civil—July 12, 1902. No. 49-489 D.

Goods Locomotive for the Southern Railway of France. Illustrated detailed description of a compound engine. 1700 w. Engng—July 18, 1902. No. 49628 A.

Helping Engines. F. F. Gaines. Read before the Saratoga Convention of the Mas. Mechs' Assn. Considers the conditions that determine the economy of using a helper, and the factors which determine the size. 2500 w. R R Gaz—June 27, 1902. No. 49154.

Locomotives for the Mexican Southern. General dimensions with illustrations, of a ten-wheel narrow-gauge engine, and a consolidation narrow-gauge engine. 500 w. Ry Mas Mech—July, 1902. No. 49550.

Mineral Locomotive, London and North Western Railway. Illustration with brief description. 350 w. Engr, Lond—July 18, 1902. No. 49633 A.

Modern Locomotive Engine Management. T. McHattie. Read before the Canadian Elec. Club. Comments on the improvements made in the locomotives of the last thirty years, and the modern safety methods and appliances, and the requirements for handling them. 1600 w. Can Engr—July, 1902. No. 49211.

The Construction of a First-Class French Locomotive. Describes the con-

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struction of a first-class four-cylinder compound express engine as carried out at the Belfort works. 3200 w. Engr, Lond—July 4, 1902. Serial. 1st part. No. 49374 A.

The Oldest-Working Locomotive in the World. Illustrates and describes an engine built by George Stephenson in 1822, still at work after 80 years of continuous service on the Hetton Railway. 800 w. Engr, Lond—July 18, 1902. No. 49631 A.

The Schmidt Locomotive. Illustrated description of interesting locomotives adapted for the use of superheated steam on the Schmidt system, with information concerning their performance. 2000 w. Engng—June 20, 1902. No. 49131 A.

Why Large Locomotives Lack Economical Efficiency. F. P. Roesch. Practical demonstration on the road, of theory enunciated by Prof. Goss. 2700 w. Loc Engng—July, 1902. No. 49202 C.

Motive Power.

The Situation With Motive Power. From the address of A. M. Waitt at the convention of the Am. Ry. Mas. Mechs' Assn. Reviews the developments of the last five years, considering locomotive design and construction, operating expenses and efficiency, shop practice, etc. 4000 w. Ry & Engng Rev—June 28, 1902. No. 49103.

Oil Fuel.

Apparatus Used in Roumania for Burning Petroleum Residues in Locomotives (Des Dispositifs Employé en Roumanie pour Bruler les Résidus de Pétrole dans les Locomotives). Illustrated descriptions of the Urquhart, Holden and Körting oil burners. 600 w. Rev Technique—June 25, 1902. No. 49712 D.

The Use of Oil Fuel on the Southern Pacific. P. Sheedy. Drawings and description of the arrangements for burning fuel oil on the engines. 700 w. Am Engr & R R Jour—July, 1902. No. 49242 C.

Truck Springs.

Equalizing Apparatus for Bogie-Trucks (Rückstellvorrichtung für Drehgestelle bei Lokomotiven). M. Kuhn. An illustrated description of hydraulic, spring and lever apparatus for equalizing the turning and side-motions of locomotive bogie-trucks. 1800 w. Glasers Annalen—June 15, 1902. No. 49425 D.

Valve Gear.

Valve Gear for Four-Cylinder Balanced Compound Locomotives—Von Borries Patent. From an article in *Glasers Annalen für Gewerbe und Bauwesen*. Illustrated description. 600 w. R R Gaz—July 25, 1902. No. 49666.

Water Supply.

Modern Water Supply for Locomotives. F. M. Whyte. Extracts from a report to the Mas. Mechs' Assn. Showing the present "state of the art." Considers the sources, pumping power, reservoir tanks, water cranes, track tanks, etc. Followed by general discussion. 7000 w. R R Gaz—July 11, 1902. No. 49357.

NEW PROJECTS.

Abyssinia.

Railways in Abyssinia. A summary of the situation concerning railway communication and a discussion of the effect. 1700 w. Transport—July 18, 1902. No. 49614 A.

Africa.

Prospective Railway Development in British Equatorial Africa. C. Stewart Betton. Describes this region, discussing the difficulties to be met, etc. 3800 w. Jour Soc of Arts—July 4, 1902. No. 49331 A.

The Cape to Cairo Railway. Information concerning railroad development in South Africa. 800 w. U S Cons Repts, No. 1393—July 16, 1902. No. 49389 D.

Bridgeport, Conn.

The Bridgeport Improvement on the New York, New Haven & Hartford. Illustrates and describes extensive improvements, including a viaduct which will eliminate some 25 grade-crossings, a large new station, etc. 2800 w. R R Gaz—July 25, 1902. No. 49664.

Mountain Ry.

The Alamogordo & Sacramento Mountain Ry. Illustrations with brief description of a road presenting unusual engineering problems. 500 w. Ry & Engng Rev—July 19, 1902. No. 49588.

The Famous Oroya Railroad of Peru, Which Climbs Higher Than Any Other on the Globe. E. C. Rost. A brief account of a road which is at one point 15,665 ft. above the starting point. Ill. 1300 w Sci Am—July 12, 1902. No. 49396.

Switzerland.

The Ricken Railway (Neue Schweizerische Eisenbahnprojekte. III. Die Rickenbahn). Robert Moser. A discussion of various routes for a projected railway in the Canton of St. Gall. Maps. Serial. 2 parts. 4500 w. Schweiz Bauzeitung—July 5 and 12, 1902. No. 49473 each B.

Tehuantepec Railroad.

The Tehuantepee Railroad vs. the Isthmian Canal. An illustrated account of the rebuilding of this interesting road, which, it is thought, will prove a serious competitor of the Isthmian canal. 2200 w. Sci Am—July 26, 1902. No. 49680.

PERMANENT WAY AND BUILDINGS.

Engine Sheds.

The Slades Green Engine Sheds and Electrical Equipment. An illustrated description of the applications of electricity at these sheds of the South-Eastern &

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Chatham Ry., England. 1600 w. Transport—July 11, 1902. No. 49522 A.

Grade Crossings.

Railway Grade Crossing Protection in Texas. Gives the Texas Railroad Commission's requirements and recommendations for interlocking systems. 2000 w. Eng News—July 17, 1902. No. 49603.

Grades.

What is Meant by a Grade Stated in Per Cent? Carl Hering. An explanation. 800 w. St Ry Jour—July 19, 1902. No. 49580 D.

Grain Elevators.

Grain Elevators of the Grand Trunk Ry. at Portland, Me. Illustrates and describes the elevators and conveying system at Portland. The most recently completed elevator has a capacity of 1,500,000 bushels. Many interesting features are described. 1700 w. Ry & Engng Rev—July 12, 1902. No. 49518.

Rails.

Steel Rails: Relations between Structure and Durability. Robert Job. A report of investigations made to determine qualities which resulted in fractures, or in rapid wear in service, and to find the means of reducing these to a minimum. Plates. 3900 w. Jour Fr Inst—July, 1902. Serial. 1st part. No. 49292 D.

See Mining and Metallurgy, Iron and Steel.

Roundhouses.

Up-to-Date Roundhouses. A committee report of the Master Mechanics' Assn. in which Mr. Robert Quayle describes and discusses plans of terminals recently constructed; Mr. D. Van Alstine presents his ideas of an ideal plan; Mr. G. M. Basford considers the details of terminals, and Mr. V. B. Lang discusses the operation of locomotive terminals. Ill. 6000 w. R R Gaz—June 27, 1902. No. 49152.

Scotland.

"Boulder" Signalling and New Express Locomotives on the Caledonian Railway. Norman D. Macdonald. A description of the unique arrangements for safety over a road made dangerous by falling rocks. Also illustrated descriptions of the locomotives used. 1100 w. Ry Age—July 25, 1902. No. 49684.

Shops.

The Chicago and Alton Shops at Bloomington, Ill. An illustrated description of these extensively remodeled shops and their new equipment. 3200 w. R R Gaz—June 27. 1902. No. 49156.

Signals.

Automatic Train Order Signal, Hocking Valley Ry. An illustrated description of the De Wallace system, which gives automatically a warning to the engineer, and automatically stops the train. 1600 w. Ry & Engng Rev—July 19, 1902. No. 49587.

Signaling Fast Trains in Fog. Editorial discussion, with suggestion that the signal be sounded for "all right" instead of sounding for "stop" or "caution." 2500 w. R R Gaz—July 11, 1902. No. 49358.

The Electric Danger Signals on the Erie Railroad. Illustrated description of the auto-electric installation in the Bergen tunnel, Jersey City. 1400 w. Elec Rev, N Y—July 19, 1902. No. 49586.

TRAFFIC.

Interchange Rules.

Proposed Changes in the M. C. B. Code of Car Interchange Rules. The importance of stencilling "capacity" as well as weight on the outside of all cars. 500 w. Loc Engng—July, 1902. No. 49205 C.

Record Cards.

Recording Waybill Statistics by Machinery. Describes a method of auditing freight accounts and compiling statistics relating to freight-traffic. Illustrates machines used. 3500 w. R R Gaz—July 4, 1902. No. 49276.

MISCELLANY.

Belgium.

Statistics of the Belgian Railways for 1900 (Statistiques des Chemins de Fer de la Belgique pour l'Année 1900). Abstract from government reports, giving general statistics, with tables of state and private railways. 1500 w. Rev Gén d Chemins de Fer—June, 1902. No. 49697 H.

England.

Railways: Co-ordinate and Sub-ordinate. R. H. Scotter. A discussion of the railway question in England, especially as related to light railways. 2500 w. Tram & Ry Wld—June 12, 1902. No. 49187 B.

Nineteenth Century.

The World's Railways in the Nineteenth Century (Die Eisenbahnen der Erde im 19. Jahrhundert). Abstracted from the *Archiv für Eisenbahnwesen.* A historical and statistical review of the railways of the world, with tables. 2500 w. Stahl u Eisen—July 15, 1902. No. 49452 D.

Reminiscences.

Reminiscences of Half a Century. M. W. Fornev. Interesting review of the writer's railroad career, giving many incidents and facts relating to this industry, describing early locomotives, equipment, etc. Ill. 15200 w. N Y R R Club—May 15, 1902. No. 49548.

Report.

Safety Appliances and Accident Reports. Extract from the 15th annual report of the Interstate Commerce Commission, with appendix showing the most common defects in car equipment. 14000 w. St. Louis Ry Club—June 13, 1902. No. 49290.

We supply copies of these articles. See page 975.

STREET AND ELECTRIC RAILWAYS

Cardiff.

The Electric Tramway System of Cardiff Corporation. An illustrated account of this system, giving detailed description of the plants, equipment, rolling stock, etc. 7500 w. Tram & Ry Wld—June 12, 1902. No. 49183 B.

Car Equipment.

The Electrical Equipment of an Ordinary Street Car. A. B. Lambe, Jr. Read before the Canadian Elec. Assn. Discusses the principal parts comprising the modern electric car equipment. 8700 w. Can Elec News—July, 1902. No. 49583.

Car House.

The Car House of the Eastern Tramway Company of Paris, at Lilas (Note sur le Dépôt de la Compagnie des Tramways de l'Est Parisien aux Lilas). G. Lelarge. A well-illustrated description of large car sheds of an electric railway and their complete equipment. 6000 w. Rev Gén d Chemins de Fer—July, 1902. No. 49699 H.

Chatham and District.

Chatham and District Light Railways. An account of the opening of these lines in England on June 17, 1902, and illustrated description. 3800 w. Tram & Ry Wld. July 10, 1902. No. 49678 B.

City and Suburban.

Urban and Suburban Electric Traction (Traction Electrique Urbaine et Suburbaine). M. Monmerque. A paper before the French Association for the Advancement of Science, opening a general discussion on the subject of electric traction. 12000 w. Rev Gén de Chemins de Fer—July, 1902. No. 49498 H.

Conductance.

Notes on the Resistivity of Track and Collector Rails as Affected by the Chemical Composition, etc. Sydney Woodfield. Considers the constituents of ordinary rails and their effects, giving experimental investigations and information from other sources. 2200 w. Elec Rev, Lond—June 27, 1902. No. 49163 A.

Conductors.

The Design of Conductors for Electric Railways. Frank B. Lea. Abstract of a paper read before the Glasgow and West of Scotland Tech. Col. Sci. Soc. Considers the electric path, transmission or distribution circuit employed on electric railways. 3200 w. Tram & Ry Wld—June 12, 1902. No. 49189 B.

Development.

Street Railway Development in New York State. Map showing existing and projected roads, with comments on the growth and features of interest. 1800 w. St Ry Jour—June 28, 1902. No. 49100 D.

Dublin.

The Dublin United Tramways Company. An illustrated account of the tramways of this company, which may be considered as the pioneer electrical system in the United Kingdom. 4200 w. Tram & Ry Wld—July 10, 1902. No. 49677 B.

Earnings.

Street Railway Investments and Earnings. Alton D. Adams. Showing the effect of the change from horse to electric motive power, and the extensions of roads, upon returns on invested capital. 1200 w. St Ry Rev—July 20, 1902. No. 49668 C.

Electricity vs. Steam.

Competition Between Steam and Electric Railways in the United States. Daniel Royse. Comparing the advantages and disadvantages of the two classes of roads when they are competitors. 2200 w. Transport—July 4, 1902. No. 49337 A.

Electric Cars on Steam Railroads. E. A. Evans. Read before the Canadian Elec. Soc. Showing that steam trains and electric cars can be operated on the same track with advantage. 1200 w. St Ry Jour—June 28, 1902. No. 49099 D.

See Railway Engineering, Motive Power and Equipment.

Exhibition.

International Tramways Exhibition. An illustrated review of the exhibits, with comments on the novel features. 7000 w. Mech Engr—July 12, 1902. No. 49526 A.

The Tramways and Light Railways Exhibition. An illustrated account of the exhibition and exhibits. 4700 w. Elect'n, Lond—July 4, 1902. Serial. 1st part. No. 49349 A.

Fayet-Chamonix.

The Electric Railway from Fayet to Chamonix, France (Chemin de Fer à Traction Electrique du Fayet à Chamonix). Henry Martin. A very well illustrated description of a direct-current electric railway, 20 kilometers long, near Mount Blanc, its rolling stock and hydro-electric plants. Serial. 2 parts. 2 plates. 9000 w. Génie Civil—June 28, July 5, 1902. No. 49485 each D.

Foundations.

Reconstruction of the Underground Foundations for the Paris Metropolitan

We supply copies of these articles. See page 975.

Railway. From *La Nature*. Describes the preparation of the sub-soil in certain regions that the city line is to traverse, in which extend vast quarries, now abandoned. Ill. 1000 w. Sci Am Sup—July 12, 1902. No. 49500.

Heavy Traction.

Collectors for Heavy Traction. George T. Hanchett. Calls attention to points in third rail and shoe construction, stating the requirements, and problems to be met. 3400 w. St Ry Jour—July 5, 1902. No. 49260 D.

Important Decision.

Interchange of Freight Between Steam and Electric Roads. An important decision by the N. Y. Court of Appeals concerning the right of electric railways to compel steam railroads to make connections between roads and to interchange freight. Text of Judge Haight's opinion. 2500 w. St Ry Rev—July 20, 1902. No. 49669 C.

Interurban.

Grand Rapids, Grand Haven & Muskegon Railway. Illustrated detailed description of a recently opened interurban railway in Michigan, for passenger and freight business. 2400 w. St Ry Jour—July 5, 1902. No. 49259 D.

Liverpool.

New Equipment for the Liverpool Overhead Railway. Describes the new motors which have made possible a greatly increased acceleration. Ill. 1400 w. Elec Rev, Lond—July 4, 1902. No. 49348 A.

London.

The Great Northern & City Railway. Illustrated detailed description of a London underground electric railway nearing completion, and its construction. 4500 w. Tram & Ry Wld—July 10, 1902. No. 49676 B.

New Orleans.

New Orleans & Carrollton Railroad, Light & Power Co. An illustrated article describing the topography and climatic conditions, track and roadbed, construction, rolling stock, shops, method of accounting, etc. 8000 w. St Ry Rev—July 20, 1902. No. 49667 C.

Oldham.

The Electric Tramways of Oldham. An illustrated detailed description of the line, stations, rolling stock, etc. 5500 w. Tram & Ry Wld—June 12, 1902. No. 49184 B.

Paris-Versailles.

Construction Work on the Paris-Versailles Electric Railway (Note sur les Travaux de la Ligne d' Issy a Viroflay). M. Rabut. A well-illustrated account of construction work on this suburban branch of the Western Ry. of France, particularly the viaducts and the Meudon tunnel. 5 plates. 8000 w. Rev. Gén d Chemins de Fer—July, 1902. No. 49698 H.

Power Stations.

See Electrical Engineering, Generating Stations.

Rack-Railway.

Two Swiss Mountain Railways (Zwei-Westschweizerische Bergbahnen mit Abt'scher Zahnstange). K. A. Breüer. An illustrated description of electric railways partly adhesion and partly on the Abt rack system, one between Bex, Gryon and Villars and the other from Aigle to Leysin. Maps. Serial. 2 parts. 3500 w. Schweiz Bauzeitung—June 21, 28, 1902. No. 49471 each B.

The Electric Rack-Railway of Bex-Gryon—Villars, in Switzerland. From *Le Genie Civil*. Brief illustrated description of this new line. 800 w. Eng News—July 17, 1902. No. 49607

Suspended Railway.

The Langen High-Speed Railway (Note sur les Chemins de Fer à Trafic Rapide, Système Langen). Robert Zumach. An illustrated description of the suspended electric railway at Barmen-Elberfeld, Germany, and a project for a similar one between Brussels and Antwerp. 7500 w. Rev. Universelle des Mines—May, 1902. No. 49696 H.

Third Rail.

The Baltimore & Ohio Third Rail System. Illustrated description of the recent third-rail construction, taken from an account in the recently published "Book of the Royal Blue." 1600 w. Ry Age—July 25, 1902. No. 49685.

Three-Phase.

The Stansstadt-Engelberg Three-Phase Electric Railway. Illustrates and describes features of interest on this line. 700 w. Tram & Ry Wld—June 12. 1902. No. 49186 B.

Tracks.

Special Track Work for Manchester Corporation Tramways. An illustrated description of special work where the tracks were manufactured complete, including all curved and connecting rails, without cutting or bonding rails in the street. 1000 w. Tram & Ry Wld—June 12, 1902. No. 49185 B.

Tramway Motors.

Selection of Tramway Motors: Tractive Effort and Power Required. Harold C. King. Gives a diagram showing the power required for various weights of cars running at various speeds on certain gradients, and points to assist in proper selection. 1200 w. Tram & Ry Wld—June 12, 1902. No. 49188 B.

We supply copies of these articles. See page 975.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* Londo...
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m,* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Electric Trolley Hoist.

VARIOUS attempts have been made to design an electric hoist capable of handling heavier loads than come within the range of hand hoists, and not requiring the heavy and expensive supporting structures necessary to carry the large amount of dead weight of ordinary traveling cranes, but it has remained for the Sprague Electric Company to produce and place on the market a machine of this character which will stand the use and abuse to which all such apparatus is subjected, will effectually fulfill the requirements of modern shop practice, and be commercially practical.

SPRAGUE ELECTRIC HOIST.

The hoist, as shown in the accompanying illustration, fulfills all these requirements, and is protected by patents owned by the Sprague Electric Company. It is designed to transfer light work rapidly around shipyards, factories, etc., and when supplied with trolley carriage, geared hand cross-travel and bridge-travel motor to take the place of small traveling cranes.

This hoist has many advantages over any other equipment heretofore put upon the market, and embodies a new system of motor control for electric hoists. It has a high efficiency and is much smaller and lighter than any other hoist of like capacity, and is practically indestructible. It consists of only a few parts, all of which are interchangeable. It is easily adaptable to all types of runways and bridges, and the sizes range in maximum capacities from 1,500 pounds to 10,000 pounds. The smaller sizes can be equipped with a trolley arranged to run on a single rail, or I beam, and, if so arranged, will take curves of a reasonably small radius, such as may often occur in works.

In designing this apparatus, the manufacturers have carefully kept in view the fact that it would be subjected to rough usage. All parts are made of great solidity, and of the highest grade material and all bearings have been made self-oiling, requiring but trifling attention at long intervals.

All the different movements necessary for a traveling crane, namely, hoisting, lowering, cross-travel and bridge-travel, are controlled by a simple pulling of the chains and cords connected to the mechanism, and which can be operated by the ordinary workman to be found in the machine shop, factory or other place where the hoist may be used. This is a unique feature to which special attention is called. No special crane operator or cage is necessary.

The motor and hoisting mechanism can be hung from a strap if only a hoisting and

lowering motion is desired, or they can be attached to a trolley carriage arranged for cross-travel, either by pushing the load, or by a geared hand traverse motion. A bridge-travel is also provided, the controller for which is mounted on the end of the trolley carriage, as shown in the illustration. This controller is operated by cords, the handles of which are located near the work. The bridge-travel motor itself is mounted in some convenient position on the crane. The bridge-travel motion is reversible, and in practice it is possible to obtain a very short movement in either direction.

The motors furnished with this equipment are Lundell round-type motors, entirely enclosed, and the hoist can be operated out of doors without being affected by the weather. The resistance plates for the bridge-travel controller are of the enclosed type, and have a very large overload capacity.

The Sprague Electric Company manufactures and furnishes the complete hoist as shown, consisting of hoist wheels and chain, worm and spur gear, gear cases, hoisting motor and attached cylindrical switch, trolley carriage, geared hand operated cross-travel of trolley carriage, and motor and controller for bridge-travel of crane.

The hoist and motor can also be furnished complete without trolley carriage or with trolley carriage and geared hand cross-travel, but without bridge-travel motor and controller.

The Sprague Electric Company does not manufacture cranes, but will equip them complete with this apparatus, including wiring.

A very complete description of the hoist is given in Bulletin No. 01209, which may be obtained by addressing the manufacturers in New York.

Segmental Manganese Rolls.

THE Taylor Iron and Steel Company, of High Bridge, New Jersey, are putting on the market a number of new designs, in manganese steel, of wearing parts of crushing machinery, that are very attractive to users of such apparatus who appreciate the importance of keeping down to a minimum the time lost in making repairs.

One of these designs is shown in the accompanying cut. It is probably the greatest improvement ever made in crushing rolls, for by its use the great loss of time incident to changing shells is almost entirely avoided. These segmental rolls were invented by Mr. Edward W. McCanna, at the time master mechanic of the Anaconda Copper Mining Company's smelter at Anaconda, Mont., where they have been found to be most excellent and economical in service. The shell is in segments securely held in place by clamp plates and bolts. These

SEGMENTAL MANGANESE ROLLS.

segments can readily be handled by two men, and may be replaced without moving the roll out of its frame, the complete change being made in from one-eighth to one-tenth the usual time taken where the ordinary type of shell is used.

If the shells commence to groove, this action can be stopped by changing alternate segments end for end. The possibility of doing this makes these shells particularly desirable for use in pan crushing where the ordinary shells tend to wear very unevenly.

Another application of the segmental principle is in the heads of gyratory crushers. The Taylor Iron and Steel Company furnish these heads with a special steel center fastened to the shaft with a segmental covering of manganese steel in interchangeable pieces. There is no breaking of the

head, the shaft is strengthened in its weakest part and the segments of manganese steel are readily replaced when worn out.

Compound teeth for dippers of steam dredges are coming into general use. The manganese steel tips only have to be renewed, and they last four to eight times as long as tool-steel-pointed teeth. When worn, only these tips, and not the whole tooth, have to be replaced.

The Taylor Iron and Steel Company's manganese steel is used extensively for revolving screens, wearing parts for all kinds of stone crushers, coal and coke breaking rolls, mine car wheels, etc., etc., and any further information desired will be gladly furnished upon application to the company at High Bridge, New Jersey.

Aladdin Reading Lens.

EVERY engineer who has had to use transits, sextants or similar observational and measuring instruments in dark places or at night, has felt the need of a convenient means of illuminating the scale so that readings could be made with certainty.

For this reason, the Aladdin Reading Lens, manufactured by the Keuffel & Esser Company, will be welcomed by all who work with surveying instruments in tunnels, mines and other dimly lighted places, or who are engaged in astronomical work at night.

This convenient apparatus combines a powerful miniature electric lamp with a reflector and a reading glass, all so constructed that the fine readings of verniers of surveying instruments, graduations of tapes, and other scales, can be very conveniently and accurately taken in the dark. On removing the lens the lamp is an excellent illuminator for the cross-hairs of telescopes. Its light is at the same time free from the danger of igniting gases, which makes it especially valuable in coal mines.

The miniature incandescent lamp is mounted on a light handle 4½ inches over all. An adjustable polished metal reflector partly surrounds the lamp and carries a detachable fine magnifying lens. On the handle is a spring switch which permits of establishing electrical contact for short periods by the pressure of a finger or for longer periods by the action of a sliding ring.

The lamp is connected with the battery by conducting cords 4 feet long. The battery is contained in a solid sewed leather case, 7x3¼x2 inches. It consists of 4 dry cells which, for renewal, are also furnished separately in a pasteboard box, ready to slip into the leather case. This case is of convenient size and weight for the side pocket, or it can

ALADDIN READING LENS.

be carried by a shoulder strap, with which it is provided. The complete outfit weighs two pounds, of which less than two ounces is for the lamp and conducting cords. To further save waste of battery energy, there is a switch on the outside of the leather case for cutting off the current when the lamp is not in use. The battery will give light for thousands of readings before requiring renewal.

The lamp and reflector are arranged to amply illuminate the field of the lens. The lens is a high grade reading glass, especially made for reading verniers and similar scales.

No other device is as practical, efficient, convenient and safe for the use of surveyors or engineers in mines and other dark

places as the Aladdin Reading Lens. It requires the use of one hand only, leaving the other one free for manipulating the instrument.

Any further information concerning this interesting device will be gladly furnished by the Keuffel & Esser Company, of 127 Fulton street, New York, the well-known manufacturers of drawing materials and surveying instruments.

Solar Attachment for Transit.

THE solar attachment for determining the meridian is a valuable adjunct to the transit instrument, but its use hitherto has been restricted, owing to its inaccuracy when not in perfect adjustment, the difficulty in maintaining the adjustment and its unprotected position on the transit.

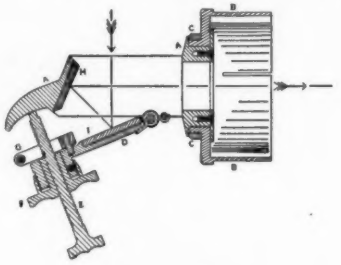
A successful attempt to avoid these objectionable features has been made by Mr. Orville F. Shattuck, a prominent mining engineer of Denver, Colo., who has designed and patented an improved solar attachment, which is arranged to fit over the objective end of the telescope in place of the cap. This makes it unnecessary to send a transit to the factory to be fitted with the attachment, for an engineer, when in the field, can order the solar instrument by measurement and can fit it himself.

By its optical construction, this solar attachment does not require the polar adjustments so difficult to maintain in other kinds,

SOLAR ATTACHMENT, FIG. 1.

being dependent for its reliability only on the accuracy of the vertical arc and the limb, the two most carefully constructed parts of the transit. For instruments having no vertical arc, a latitude level is provided, at only a small additional expense, and is even more accurate than the arc.

The operation of the solar attachment shown in the accompanying figures, which are three-quarter size, depends upon prin-



SOLAR ATTACHMENT, FIG. 2.

ciples similar to those of the sextant, where a ray of light reflected twice in the same plane emerges finally in a direction whose angle with the original ray is equal to twice the angle between the two reflecting surfaces.

In Figure 2, which is a sectional view in the plane of the attachment, the main frame AA carries the stationary mirror H and revolves axially by means of a bearing in the cap B which fits over the objective end of the transit. C is a clamp ring used in connection with the clamp and tangent screw, (not shown) for rotating the frame AA about its axis. The movable mirror I is adjustable to any required angle, being mounted on a swinging arm D, which is provided with an adjusting screw E, a graduated differential nut F and a clamp G.

The ray of light enters from above, as indicated by the arrow, and is incident upon the movable mirror I; it is thence reflected to the stationary mirror H and thence in through the object glass to the cross-wires of the instrument. Thus the maintenance of the angle between the incident and emergent ray depends upon the angle between the mirrors rather than upon the polar bearing.

The declination angle, corrected for refraction, is set off by means of the movable mirror actuated by the screw E and differential nut F, the method being to sight at some object on the horizon with the solar attachment off, the telescope level and the

vernier set at zero. Then with the lower plate clamped and the vernier set at the south polar distance, corrected for refraction, which has been previously computed, sight at the same object with the solar attachment in place, bringing the object into the cross-wires by means of the adjusting screw E and differential nut F.

Now depress the telescope to the latitude of the place of observation, revolve the solar about its axis and the transit in a horizontal plane until the image of the sun is brought to the proper position on the cross-wires.

SOLAR ATTACHMENT, FIG. 3.

The line of collimation then becomes the polar axis with the transit in the meridian, and the solar revolved about its axis will follow the path of the sun. The engineer having carefully set off his angles and knowing that his transit is in adjustment, is assured of reliable results.

After the transit has been set in the meridian the reading of the differential nut is taken and the attachment removed. The latter weighs less than three ounces and may be carried in the pocket without fear of damage.

In taking subsequent observations during the day as a check on the work, it is necessary only to set off the hourly change in declination by means of the graduated differential nut, each division of which represents one minute of arc and place the attachment in position, and if the instrument be in the meridian, the sun will come to the proper position on the cross-wires.

Another valuable feature of this solar attachment is its adaptability to underground surveying. In connection with the delicate level under the transit telescope, it is especially useful in carrying accurate traverse lines up or down shafts or steep inclines in the same manner as with side and top telescope.

Catalogue C, giving a complete description of this instrument, will be mailed on request by the sole manufacturers, Messrs. Wm. Ainsworth & Sons, of Denver, Colo.

Bituminous Macadam Pavement

THERE are pavements and pavements, but none which possess all the merits of the ideal. At least that has been the common verdict up to the present time. While many good pavements have been laid and are well known, yet every one of them has some fault or faults which remove it beyond the realm of the ideal. Last season, however, there was introduced in several New England and Eastern cities a form of pavement known as Bituminous Macadam, which possesses all the characteristics of an ideal pavement—smoothness, sure footing to horses, and durability. If the favorable reports which come from the cities that introduced this form of pavement last season are to be believed—and there is no good reason why they should not be—it would seem as if the ideal pavement had at last been discovered.

The principle on which the bituminous macadam pavement wearing surface is combined, is the reverse of the principles on which the ordinary asphalt pavement is built. In the present asphalt or tar pavement the bituminous cement is used to support fine mineral grains, such as sand, which in themselves have no firmness to sustain traffic, in such a way that the fine mineral grains will be held or supported by the bituminous cement so that the mortar or mastic will, at all atmospheric temperatures, sustain the weight of traffic, and, at the same time, resist abrasion.

The bituminous macadam is built on the principle that, independent of the bituminous cement, relatively coarse and fine mineral grains should be combined in such a

way as to have firmness in themselves to sustain the weight of traffic. The bituminous cement is supported, or held in place, by the proper arrangement of stone particles as to size. The bituminous cement is used solely for the purpose of preventing attack on the stone from water and weather, and to bind the particles together sufficiently to prevent abrasion from traffic at all atmospheric temperatures and, at the same time, provide an elastic bituminous cement or cushion between the mineral particles which will deaden the jar and prevent the wearing effect caused by the friction from the movement of its integral parts.

The ordinary method employed in its construction is to assume that a natural foundation thoroughly rolled with a heavy road roller, furnishes a solid sub-base; that a solid base of four inches, of two-inch to two-and-one-half-inch stone will, after thorough compression with a fifteen to twenty-ton roller, provide an ideal foundation for a waterproof surface, and will provide drainage to moisture accumulating from the surrounding ground. If more drainage is necessary, drains rather than extra foundations are advisable. The stone is better if very hard, but this is not so important in the foundation as in the top.

Such a foundation offers many advantages over hydraulic concrete, in that the overlying courses enter and bind into the foundation, and the foundation aids in holding the top or wearing surface in place.

On top of the stone foundation is spread, or sprinkled, a coating of specially prepared thin bituminous cement which enters the minute crevices of the surface of the stone and permits the stone in the foundation being firmly held together with the waterproof cement which is afterwards freely used over the surface of the foundation. This waterproof cement is thus enabled to grip onto the stone permanently, and, being of a hard pitchy nature, of a grade of flexibility that will bind the surface of the foundation firmly in place, it makes the foundation itself rigid before the wearing surface is rolled in.

On top of the foundation thus prepared is spread a layer of the wearing mixture which should have a thickness of about two inches after its maximum compression. This mixture is a carefully prepared combination of one-inch and two-inch stone, having voids filled with receding sizes to a dust or powder of stone. Some sand may be used to aid in filling voids when necessary.

The mineral or stone part is dried and heated in a modern dryer and is then separated by screening with rotary screen into its sizes, varying from fine dust, which is less than 1/200 of an inch in diameter, to the largest size used. The several sizes of stone are then mixed in predetermined proportions, so as to reduce the voids to about 10 per cent., in a modern "twin pug" steam power mixer, and the hot bituminous cement is added in the mixer in sufficient quantity to not only coat every particle and fill all of the remaining voids, but with enough surplus to put the mixture, after compression, in a rubbery and slightly flexible condition.

The mixer makes seventy-five revolutions per minute, and every particle of mineral is coated in about fifteen seconds, but the mixing is continued about two minutes to provide absolute uniformity of distribution of bitumen and mineral. The whole is dumped by gravity into wagons and hauled to the street, where it is spread in the same manner as an asphalt pavement. It is then rolled with a fifteen to twenty-ton road roller, which gives many times as much compression to the inch run as the ordinary asphalt roller.

After a thorough and continuous rolling there is a little honeycombed appearance at the surface where coated particles of stone come together, but the body of the mixture on being broken shows denser under the magnifying glass than any bituminous wearing surface that has heretofore been used.

Good rolling is an essential feature, as it helps to place the particles where they belong, and continued rolling forces out the minute air bubbles and forces the surplus bitumen into the fine voids, leaving the body of the surface so dense that it cannot be rotted or displaced by traffic. It also adds to the life of the bituminous cement by protecting it from exposure to the elements in minute semi-detached particles. The rolling should commence as soon as the surface is spread, and it is advisable that one heavy roller should not be required to do more than 1,000 square yards of surface per day.

On top of the surface thus made, partly to heal and seal the surface from attack, and partly to hold and help make a practical wearing surface, there is poured and rubbed into it all of the quick drying bituminous cement that it will take. This leaves the surface as sticky as if freshly painted.

On this surface is spread a coat of fine stone chips which adhere to the bitumen on the bottom and present a rough, gritty surface to travel. The rolling of these rough chips into the surface has the effect of putting the pavement under greater pressure, and forces as much stone into the surface as it can possibly receive, thus making it more gritty and suitable for travel.

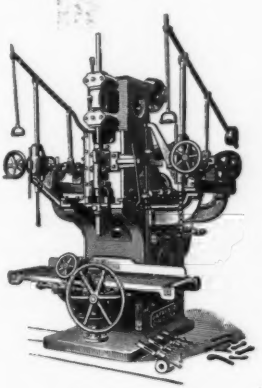
The above method gives an ideal road surface, and with traffic and wear it will always maintain a large part of the roughness of a perfect macadam road as compared with the smoother and polished surface of the asphalt. It is relatively as smooth for wheels as asphalt, the coarse particles of the surface hold moisture and dust longer, and the pavement will always be less slippery and less dusty and can be made more durable than any bituminous pavement previously laid. The click from the horses' hoofs is much reduced as compared with asphalt, and the pavement is one of the most noiseless in use. This is especially noticeable in cold weather, when all bituminous pavements are the hardest and most resonant.

This pavement has given remarkable satisfaction during the short period it has been in use, and is most highly commended by engineers, city officials, road users, and citizens generally. It has been endorsed by the Road Drivers' Association of New York City and by the Associated Road Users of America, and many other testimonials have been received by the manufacturers and layers, the Warren Brothers Company, of New York and Boston., who will be pleased to furnish any further information that may be desired.

Hollow-Chisel Car Mortiser.

ONE of the most powerful machines for mortising, especially in car shops, is herewith represented. It has many points of advantage which make it one of the best of its class now on the market and an examination into its merits will prove interesting. Much care has been exercised to make it strong, simple in construction and powerful in operation; so doing away with the necessity of laying out the work or cleaning the mortises.

The chisel ram carries the boring spindle that prepares the work for the chisel, there being stops to regulate its vertical and lateral travel. The vertical movement is 16 inches; the extreme lateral motion, 14 inches. The reciprocating motion is produced by reversing the friction and gearing. The table is a steel traveling bed of any length desired, and has stops to regulate the length of the mortise. It is easily operated, and has an adjustable clamp for firmly holding the work.



CAR MORTISER.

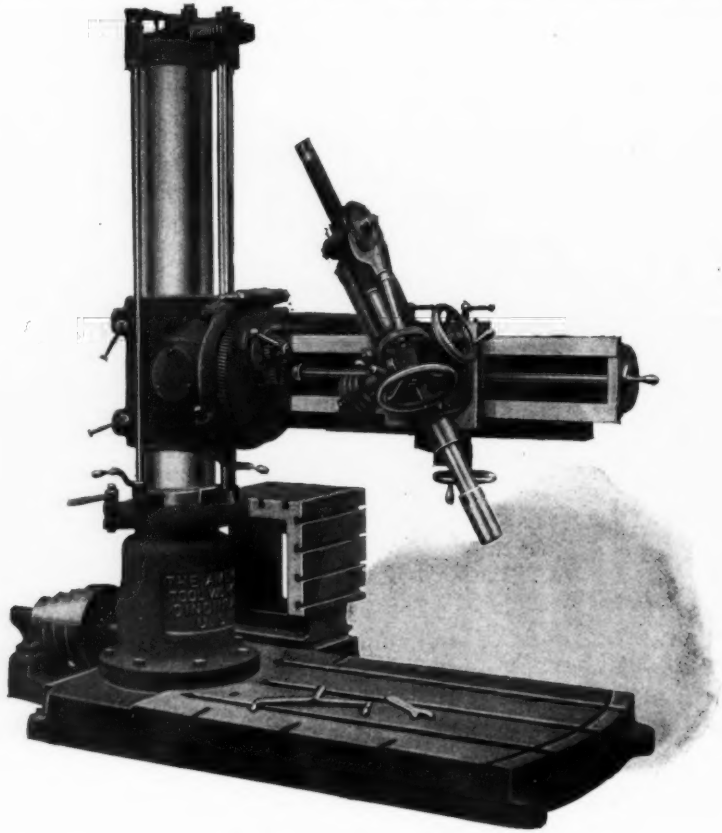
A boring attachment is at each end of the frame, at a distance enabling them to be adjusted to an angle of 30 inches in either direction. They are especially convenient for joint-bolt boring, and save much handling of material and much valuable time. They have vertical adjustment of 20 inches, and lateral adjustment of 12 inches. The frame is massive, all parts are put solidly together, provision is made for taking all wear, and rolls are provided to reduce the friction to a minimum.

The makers of this machine, J. A. Fay & Egan Company, of No. 212 to 232 West Front street, Cincinnati, Ohio, will be pleased to furnish any information desired, as well as cuts and terms, and will send their new catalogue free to those interested.

Universal Radial Drill.

IN the accompanying engraving we illustrate the latest Full Universal Radial Drill brought out by The American Tool Works Company, of Cincinnati. The element of strength has played an important part in the design and construction of these machines. With that end in view the column has been made unusually large and is firmly supported by an inside stationary stump extending its entire height with a bearing at the top, affording exceptional stiffness and rigidity. The arm is of new and original design. It permits of all lower driving gears being brought direct to central driving shafts through the medium of bevel gears mounted on a vertical shaft and enclosed in the arm. It is raised and lowered rapidly by a double-thread coarse-pitch screw running in a bronze nut directly on the load line, reducing friction to a minimum.

The head is universal in its action, and is clamped instantly in any position by means of fixed binders at the top. Movement along the arm is controlled by a hand wheel through rack and multiple gearing. The spindle has three changes of feed and sixteen changes of speed. The back gears are placed on the arm, and can be thrown in or out while the spindle is in motion by a convenient lever. The correct vertical position



FULL UNIVERSAL RADIAL DRILL.

is determined by a dowel-pin in the head, thus insuring accuracy of alignment with platen.

The tapping attachment shown in the illustration is invaluable where a great amount of tapping is to be done. By means of a patented friction gearing located in the arm, the tap can be advanced to its required depth, the lever thrown instantly by the operator without leaving his position, the spindle reversed and tap backed out at accelerated speed by throwing from "gears-in" to "gears-out."

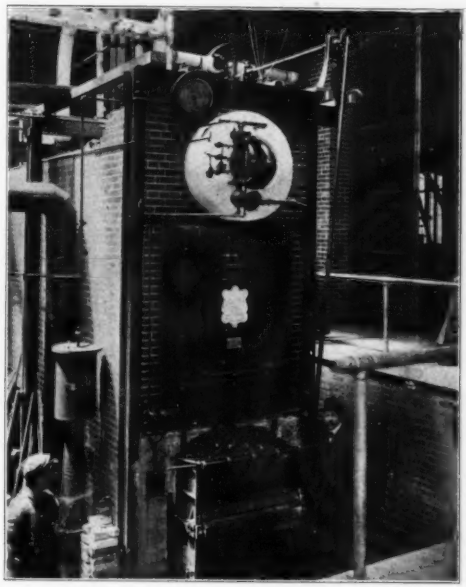
The motion of the spindle can be stopped instantly either by the lever controlling the back gear or the lever controlling the friction gearing, thus obviating all necessity of stopping the entire machine through the countershaft.

Further particulars can be obtained from the circular issued by the makers.

Automatic Smokeless Stoker.

THE recent plague of smoke in New York and many other cities, caused by the necessary burning of soft coal as the only available combustible, makes the present a peculiarly opportune moment for the introduction of a smoke-consuming apparatus. If, moreover, such a device can be combined with a mechanical stoker, and the whole applied to all forms of boilers at a reasonable cost, it will be an extremely valuable adjunct to the steam plant.

Such an apparatus appears to be the "Peerless Automatic Smokeless Stoker," invented by Mr. F. Girtanner, which has passed successfully through severe tests, and is now in satisfactory commercial operation.



PEERLESS AUTOMATIC SMOKELESS STOKER.

This stoker is simple in construction. It consists essentially of a traveling grate on which the coal is ignited and which conveys the incandescent coal to an inclined grate provided with shaking grate bars. At the bottom of the inclined grate there is a dumping plate for removing the ashes and clinker.

In the front a hopper receives the coal. A mechanical movement is exerted upon the drums which carry the endless chain bars of the grate towards the interior of the furnace. The same mechanical movement operates a rod which causes the inclined slid-

ing grate to shift from right to left. The coal is completely coked before it reaches the hottest part of the furnace, and all gases and smoke are completely and effectually prevented before reaching the outer air, making perfect combustion. The mechanism also works perfectly without the automatic attachment, and can be fed by hand in the ordinary way.

Among the advantages claimed for the "Peerless Automatic Smokeless Stoker" are the following:

(1) It develops high temperature and oxidizing action to insure perfect combustion of the free or separate carbon which forms the visible smoke. (2) It insures regularity of action under the varying conditions induced by charging fresh coal and cleaning fires, inattention of fireman, and so on. (3) It is not susceptible to derangement under the conditions likely to obtain in use, such as carelessness of firemen, inferior water and bad clinkers. (4) The cost of operation is much smaller than with ordinary grates. (5) The capacity of the apparatus is such that efficient action is secured not only when the boiler is working up to its full rated capacity, but even when forced in order to meet extraordinary demands. (6) The apparatus is readily adjustable to all forms of boilers and boiler settings, and is susceptible of application to boiler settings where the space is already limited. It is of comparatively low first cost, notwithstanding the saving in fuel and labor which would warrant the use of a more costly furnace. Repairs are small in amount, easily made and low in cost. It can be operated without injury to the boiler or the other accessories. (7) As has been shown by tests, it will save in any plant where fuel, labor, capacity, and general efficiency are considered, from 15 to 30 per cent. of the cost of steam production as compared with other forms of furnace. (8) It insures perfect combustion in the generation of steam, involving absence of soot, smoke and cinder nuisances. (9) A strong draught is always at command and under the control of the operator, no matter what fuel is used. As combustion is perfect, greater heat can be obtained. (10) No skilled labor is required. (11) It allows the use of bituminous coal in cities and towns where this is now forbidden, thus effecting a great saving in expense to manufacturers, railroads, etc., who are now compelled to use anthracite coal. (12) Every part of the apparatus is made of the very best material throughout. The driving gear is provided with means to stop the stoker instantly and will allow of five changes of speed. (13) Each stoker is supplied with a small engine so that the fires can be handled independently. (14) It will consume crude petroleum oil mixed in the proportion of one ton of slack to 500 pounds of oil, giving greater heat and efficiency than coal alone at much less cost, without a particle of smoke, thus providing the cheapest kind of fuel. This experiment has been made with the stoker with great success.

These are not claims that wait a practical demonstration, nor bald statements, based on speculations or hearsay, but they are fully substantiated facts, adduced from close observation of the system which has been and is now in operation under conditions of a most exacting and severe character, using the poorest coal that could be found. Furthermore, they are corroborated in every detail by the judgment of eminent engineers, who have seen it in operation, and who agree unanimously that the system fully accomplishes all that is claimed for it.

This stoker will be installed and allowed a trial of thirty days, and if these representations are not confirmed, it will be removed at the expense of The Peerless Automatic Smokeless Stoker Co., S. L. Simpson, Pres., 11 Broadway, New York, which will gladly furnish further information on application.

Industrial Notes.

—The Pelton Water Wheel Company of San Francisco and New York, report an unusually large number of both foreign and domestic orders for the last month. The Clark Electric Co., of Ophir, Utah, will require 2,000 H. P. for driving their generators, which will generate power for the mines and towns about Tooele County, Utah. The Pacific Portland Cement Co., of Spokane, Wash., are about to install Pelton wheels to operate their entire plant. A foreign order of unusual interest, from both its magnitude and the fact that it was secured in competition with all the manufacturers of Europe, has just been received from the Spanish Cement Mills, near Barcelona,

Spain. This order calls for several miles of heavy sheet-steel riveted pipe, and water wheels to generate power for this entire plant, which is one of the largest of its kind in the world. Among other orders might be mentioned those from the Salvador Mining Company, Rix Compressed Air & Drill Co., Ledge Mining & Milling Co., Lahaina Plantation Co., Ouray Electric Light & Power Co., and the Ardjeaarie Electric Power Transmission Co., of Batavia, Java.

—The exhibition of ship riveting, which the Chicago Pneumatic Tool Company are making in Glasgow, Scotland, is proving highly successful. The work there is in charge of Mr. E. Guennell, for many years superintendent of the Chicago Shipbuilding Company at South Chicago, Illinois, and he reports most favorable progress and great interest on the part of the shipbuilders on the Clyde. To further assist him in his work, the Chicago Pneumatic Tool Company have sent two expert riveters from the Chicago Ship Yards to Glasgow. The Chicago Pneumatic Tool Company are applying American methods to their European business, and have recently sent Mr. F. D. Johnson, manager of their New York Office, to push business there, and have also sent Mr. George H. Hayes to take charge of the mechanical work in their London works. Mr. W. H. Armstrong, from the headquarters of the Chicago Pneumatic Tool Company at Chicago, will have charge of the New York Office of that company.

—Jones & Laughlins, of Pittsburg, Pa., are continually making additions to their electrical equipment, and have just recently ordered from the Westinghouse Electric & Mfg. Co. one 800 K. W., D. C. generator, two 150 K. W., motor-driven, two-phase alternators, and two 125-light, motor-driven arc generators.

—The Hayden & Derby Mfg. Co., 85-87-89 Liberty Street, New York City, are advised that the Metropolitan 1898 Injector, model "O," has been adopted by the Philippine Insular Government as the standard on their class "A" cruisers, fifteen of which have been fitted with these injectors. The contract was secured by F. W. Horn & Co., Yokohama, Japan, who are the agents for The Hayden & Derby Mfg. Co., at that point. It is of interest to note that before the goods of this class were adopted as a standard the most careful and exhaustive tests were made with the view of selecting devices which had the greatest merit, and the adoption of the Metropolitan Injectors under such conditions fully endorses the claims of superiority made for these instruments by the manufacturers.

—The Pittsburgh Gage & Supply Co., Pittsburgh, Pa., will furnish three 250-H. P. water-tube boilers for the Susquehanna Iron & Steel Co.'s new plant at Columbia, Pa., and have recently closed contracts to furnish a complete White Star filtering system for a vertical cross compound blowing engine for the National Steel Co., and filtering systems for the electric department of the Carnegie Steel Co.'s Homestead Works, and the Wheeling Steel & Iron Co., Wheeling, W. Va.

—For the first time in five years Niagara was out of harness Sunday, June 1st. The rush of water into the great tunnel of the Niagara Falls Power Company was shut off, and the full volume of the river poured through the awful gorge. The managers of the company wished to inspect the tunnel. What condition was it in after 32,400,000 cubic feet of water had hurried through it every hour for five years? At half past one o'clock that Sunday morning a party of engineers composed of Vice-President William B. Rankine, and Edward D. Adams, of the Board of Directors; William A. Brackenridge, resident engineer, and Clemens Herschel, consulting hydraulic engineer of the Niagara Falls Power Company, and others put on rubber suits and descended into the tunnel. Splashing along through a stream eighteen inches deep, caused by the leakage at the gates, they flashed their torches upon the walls in anxious search for signs of wear. They found none. From one end to the other, the tunnel was as strong as the day when it was finished. Of the 19,000,000 bricks used in building it, not one was out of place. The inspection was finished by seven o'clock. The engineers returned to the surface of the earth, the gates were lifted, and one-thirtieth of the mighty stream of Niagara plunged into the tunnel. Incidentally, the inspection proved that "Giant" Cement deserves its name. Tunnel, wheel-pits and power-house were all built with "Giant." The American Cement Co. of Philadelphia, furnished about

60,000 barrels for the central plant at Niagara Falls and related enterprises, such as the Niagara Falls Paper Co. and the Pittsburg Reduction Co. The work at the tunnel was carried on in circumstances of peculiar difficulty. William S. Humbert, engineer in charge of construction, says that the "Giant" cement was in some cases "deposited" under water, and in the sumps soon after the masonry was laid the water rose and covered the "green" work, but it seems to have made no difference in the strength and soundness of the work.

—There was a rock-drilling contest with air drills at Idaho Springs, Colorado, in July, near the entrance to the Newhouse tunnel, where a face of country rock was specially prepared by making a breast for the work. The material here is a schist, and is regarded as a rock of more than average hardness for drill work. The power was supplied by the compressor at the Newhouse tunnel plant. The contest was open, with an entrance fee of $10, and the contestants used whatever machines they pleased. While there were many entries, only eleven contestants carried through the work to a finish. The first prize of $200 was won by Alf Ellison and Alf Fredman of Idaho Springs, employees at the Central tunnel, operating a Water Leyner rock drill. They drilled two nine-foot holes, including changing, setting up and tearing down in 42 minutes and 15 seconds. They were also awarded the special purse of $50 offered by the Leyner manufacturers for the best record made with that make of machine. The second prize of $100 was awarded to Bert Zeilor and George Wehman of Idaho Springs, also with a Leyner, their time being 44 minutes and 50 seconds. The third prize of $50 was won on a tie by T. F. Howard and John Matthews of Empire as one crew and Gus Carlson and Ed Shannon of Idaho Springs as the other, both crews using Leyner drills. Their time was 49 minutes and the money was evenly divided between them.

—The Denver Engineering Works Company have in process of construction the following electric hoists: Three 2-H. P., two 5-H. P., two 10,000 pounds capacity, and two 150-H. P. for the Penoles Mine in Old Mexico; one 135-H. P. for the Utah Fuel Company; one 50-H. P. for The Kendall Gold Mining Company, Montana; one special 50-H. P. for the Montana Coal & Coke Company, Montana; one 50-H. P. for the Northern Pacific Railroad Company; one 5-H. P. for Hendrie & Bolthoff; and one 5-H. P. for The Mine & Smelter Supply Company; besides one 100-H. P. endless cable, electrically-driven winding engine for The Anaconda Copper Mining Company. They have also recently shipped one 25-H. P. electric hoist to The Candelaria Mining Company, Mexico; one of 15-H. P. to Harron, Rickard & McCone, San Francisco; and one of 135-H. P. to The Commodore Mining Company. They make the announcement that they have ready for distribution their new Electric Hoist Bulletin of 30 pages, fully illustrated, and containing construction drawings of all their standard hoists, and also their new Electric Rock Drill Bulletin.

—On July 15, 1902, The Simplex Electric Heating Company will take over and conduct the electric heating and rheostat business which has been developed by the "Heating Department" of The Simplex Electrical Company. This change separates the electric heating business from the manufacture of insulated wires and cables and is calculated to furnish opportunity for carrying out a broader policy in the conduct of the business. Additional factory buildings now under construction, will provide more than three times the present capacity, and will permit of more prompt service than has been possible in the past, owing to limited factory facilities. The management will remain the same as heretofore. The principal office of the company will be at 77 Cornhill, Boston, Mass., where all correspondence about money matters should be addressed. Correspondence relating to orders may be sent to 116 Franklin street, Cambridgeport, Mass. The Chicago office will remain in charge of Mr. H. R. Hixson, 1137 Monadnock Block, Chicago.

—The following quotation from the report of the committee appointed by the Lords Commissioners of the British Admiralty to consider certain questions respecting modern types of boilers for naval purposes may be of interest to our readers: "In the course of their investigations, the committee have watched the Babcock & Wilcox boilers fitted in the S. S. 'Martello,' of the Wilson Line, employed in the Atlantic trade between

Hull, Boston and New York, and copies of the reports of their inspections have from time to time been forwarded to their Lordships. These inspections have taken place at the end of every round voyage for 14 months, and the committee's opinion is that these boilers have stood the test of usage in the mercantile marine extremely well. The vessel has run about 91,000 miles since the boilers were put in, and has usually been less than a week in port at either end; the only repairs required have been those of the ordinary upkeep of any boiler, such as firebars, brickwork, etc., and only six tubes have required renewal. This opinion is strengthened by the inspections of boilers of the same type fitted in the 'Numidian,' the 'Buenos Ayrean,' and the 'Turret Cape.' In the case of the last named vessel, the boilers have been in use seven years, and cannot have been as well looked after as they would have been in the navy, and their condition when examined recently was satisfactory. The committee have also examined and tested boilers of the same type in H. M. S. 'Sheldrake,' and find that, although they have been in use for four years, their condition is good and they have given little trouble. From the information which has been brought to the notice of the committee, it appears that water-tube boilers are being very little used in large ships belonging to the mercantile marine, and that their use in such ships is increasing very slowly. In the British mercantile marine, the only type of water-tube boiler installed in ocean going vessels is the Babcock & Wilcox, in some ships of the Wilson and the Peterson-Tate Lines, and in three ships of the Allan Line; in these last, however, only one water-tube boiler is fitted in each vessel to assist the original cylindrical boilers. In the United States mercantile marine, Babcock & Wilcox boilers are used to a small extent, principally in the ships plying on the Great Lakes, and in the American Navy many Babcock & Wilcox boilers are in use." It is interesting to note that throughout their investigations, which lasted over a period of nearly two years, the committee were only able to examine into the merits of one type of water-tube boiler successfully operating in the merchant marine, and as will be seen by the foregoing, this was the Babcock & Wilcox.

—The Standard Steel Car Company is equipping its new plant for electric driving throughout. A recent purchase from the Westinghouse Electric & Mfg. Co. comprises two 375 K. W., A. C. generators, one 400 K. W., D. C. generator, and a 300 K. W. rotary converter for use as a connecting link between the two. This company has also purchased about fifty induction motors, which will be used largely for direct connection to machine tools.

—The Philadelphia Pneumatic Tool Co. has concluded arrangements for representation in South Africa, with headquarters at Johannesburg. This agency will be in charge of General Samuel Pearson, late of the Boer forces. General Pearson has been in the United States for some months, in the interests of his government, in the attempt to have the mule shipments from Port Chalmette stopped. Now that peace has been declared he will return to his former business in machinery lines and will handle the accounts of the Philadelphia Pneumatic Tool Co. and others. Before coming to America General Pearson saw much active service in the field, for a time in charge of railway traffic.

—The Sprague Electric Co. is achieving great success in securing many important contracts for its motors and generators, and both its Watsessing factory and New York conduit factory are rushed to the utmost.

—The Globe Machine & Stamping Co., at 970-972 Hamilton Street, in Cleveland, have been increasing their capacity considerably during the past month. They have put in a Fosdick & Holloway radial drill, a Pond planer, a Reed lathe with taper attachment, a Knecht sensitive drill press, a Steptoe shaper and a LeBlond universal miller with vertical milling attachment. They report that orders have been coming in so rapidly that they were barely able to keep pace with the demand by getting in their new tools. They have recently entered numerous orders for drop forging dies, and punching and forming dies for sheet metal work. They pay particular attention to developing new machinery and special devices. Mr. Fred G. Nicolaus, formerly with the Browning Engineering Co., and later with the National Stove & Illuminating Co., has recently become the superintendent of the Globe Machine & Stamping Co.

—The Ashcroft Mfg. Co., 85-87-89 Liberty Street, New York, are advised that the Tabor Steam Engine Indicator has been adopted by the Philippine Insular Government as their standard on Class "A" cruisers, fifteen of which have been equipped with these well known indicators. Before the goods of this class were adopted as a standard the most careful and exhaustive tests were made so as to select only devices of the greatest merit. The selection of the Tabor Indicator under such conditions fully endorses the claims of the manufacturers that it is recognized as the highest standard in all parts of the world.

Pawling & Harnischfeger, Milwaukee, Wis., makers of electric cranes and hoists, have just acquired the Gardiner Campbell Company property adjoining their works. This property is 200 by 150 feet in size, and the three story building is being entirely remodeled to supply additional machine shop facilities, also to provide extra pattern storage. The foundry is being changed over, and an addition made thereto, and in the entire building will be placed a modern foundry equipment. Among the improvements will be two P. & H. electric traveling cranes. The present power plant is being much enlarged, and new boilers and engines and another generator will be provided. These improvements will considerably shorten the time required to complete a crane or hoist.

—H. G. Barr, the maker of machine tools and special machinery, has greatly increased his manufacturing facilities at Worcester, Mass., and will in future carry a much larger stock on hand.

—Prof. Peter T. Austen, the chemical expert, of 80 Broad Street, New York, wrote for the "Forum" a very interesting article on "The Utilization of Waste," which has now been reprinted in pamphlet form.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Acetylene Mine Lamp.

Circular with a description of "The Standard" acetylene mine lamp, and an account of specially prepared calcium carbide. John S. Cummings & Co., Tunnelton, W. Va.

Air Compressors.

Neat booklet, with illustrations and dimensions of air compressors and air receivers. Herron & Bury Mfg. Co., Erie, Pa.

Arc Lamps.

Bulletin No. 1026 and folder with well-illustrated descriptions of "Wood" enclosed, direct-current, series arc lamps. Fort Wayne Electric Works, Fort Wayne, Ind.

Armour Institute.

Year Book for 1902-1903, giving comprehensive and detailed information of courses in mechanical engineering, electrical engineering, civil engineering, chemical engineering and architecture. Armour Institute of Technology, Chicago.

Automobiles.

An attractive catalogue and price list, with well-illustrated descriptions of seventeen models of Columbia electric and gasoline automobiles. Electric Vehicle Co., Hartford, Conn.

Band Saw Accessories.

Neat folder, with illustrated descriptions of a self-acting vise for filing band saws, the equal-blow setting machine and the Pineo band saw guide. The New Britain Machine Co., New Britain, Conn.

Chain Gear.

Attractive booklet with well-illustrated descriptions of the Renold silent chain gear, in which the chain is made of stamped links of peculiar form, and some typical applications. Link-Belt Engineering Co., Nicetown, Philadelphia.

Coal Handling.

Mailing card with illustrations and brief description of apparatus for unloading coal from vessels. C. W. Hunt Co., West New Brighton, N. Y.

Connecting Rods.

An illustrated catalogue and price list of connecting rods and their parts, for steam engines. Standard Connecting Rod Co., Beaver Falls, Pa.

Electric Heaters.

A neat little folder, illustrating and describing the Travellers' Electric Stove, a portable outfit which can be used in any place where there is electric current on tap. The Simplex Electric Heating Co., Cambridgeport, Mass.

Electric Hoists.

Bulletin No. 01209, with well-illustrated descriptions of electric trolley hoists with a remarkable capacity for their weight. Sprague Electric Co., New York.

Electric Lighting.

Monthly illustrated bulletin, with news about central station electric lighting in New York City, and directory of wiring and installation contractors and supply dealers. New York Edison Co., 55 Duane Street.

Electric Machines.

Bulletin No. 10, descriptive of bipolar electric motors and dynamos in sizes from one to six kilowatts. Hertner Electric Co., Cleveland.

Electric Switches.

Bulletin No. 127, with well-illustrated descriptions and price lists of S. K. C. electric switches for all varieties of service, from the simplest small knife switch to the high-capacity combined oil switch and circuit breaker. Stanley Electric Manufacturing Co., Pittsfield, Mass.

Electric Wire.

Pamphlet with reference tables of wires for electrical purposes, descriptions of various kinds of wire and rail bonds, and list of products. American Steel & Wire Co., Worcester, Mass.

Feed Pumps.

Folder, with illustrated description of variable-stroke boiler-feed power pump, "Leitch Patent," in which the amount of water delivered can be regulated to a nicety. Cameron-Tennant Machine Works, Richmond, Va.

Feed-Water Heaters.

Catalogue No. 2, with illustrated descriptions of Riblet feed-water heaters and purifiers and Hardwick feed-water heaters. Erie Manufacturing and Supply Co., Erie, Pa.

Grates.

Folder, with illustrated description of the Martin anti-friction rocking grate, and partial list of users. The Martin Grate Co., Chicago.

Green's Economizer.

A very well illustrated and comprehensive catalogue describing Green's improved patent fuel economizer and feed-water heater for steam boilers, with many views of plants where it is used, records of tests and tables of useful information. The Green Fuel Economizer Co., Matteawan, N. Y.

Igniting Dynamo.

Neat booklet, illustrating and describing the "Quick Action" igniting dynamo for butt-spark and jump-spark gas and gasoline engines, and also spark coils and sparking plugs. The Miller-Knoblock Electric Manufacturing Co., South Bend, Ind.

Locomotives.

Bulletin No. 35, with handsomely illustrated descriptions of rear-truck locomotives, of the "Atlantic," the "Prairie" and the "Mikado" types, and of the Rushton patent, radial-swing truck, under firebox. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Catalogue No. 3, with well-illustrated descriptions of vertical milling machines, profilers and duplex milling machines. Also a booklet with list of second-hand machine tools. The Garvin Machine Co., New York.

Oil Pump.

Attractive folder, with illustrated description of the Richardson sight-feed oil pump for engine cylinders. The Sight Feed Oil Pump Co., Milwaukee.

Pavement.

Pamphlets devoted to Warren's bituminous macadam waterproof pavement, with well-illustrated descriptions, testimonials and endorsements. Warren Bros. Co., Boston.

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Well-made, cloth-bound catalogue of 204 pages, with illustrated descriptions

and price lists of wrought-iron and steel pipe, cast-iron, malleable-iron and brass fittings, valves and cocks, radiators and coils, square and rectangular tubing. Western Tube Co., Kewanee, Ill.

Radial Drills.

Handsome catalogues, with descriptions and beautiful illustrations of radial drills, testimonials from users, and telegraphic code. The Fosdick Machine Tool Co., Cincinnati.

Railway Supplies.

Well-made catalogue of 148 pages, with flexible cloth covers, giving illustrated descriptions of hand, push, dump and plantation cars, switch stands and fixtures, and all kinds of railway and contractors' supplies. The Buda Foundry & Manufacturing Co., Harvey, Ill.

Refrigeration.

Neat booklet, with testimonials from many users of Barber ice-making and refrigerating machinery. A. H. Barber Mfg. Co., Chicago.

Rock Drills.

A large book, very handsomely illustrated with half tones, maps and diagrams, describing the construction of the New York Rapid Transit Tunnel, and particularly the work done by Rand rock drills and air compressors. Rand Drill Co., 128 Broadway, New York.

School of Mines.

Catalogue for 1902-1903, with illustrated descriptions of the location and courses of study and general information. New Mexico School of Mines, Socorro, N. M.

Steam Engines.

Catalogues Nos. 3 and 4, with illustrated descriptions of horizontal and vertical, automatic and slide-valve engines. Erie Manufacturing & Supply Co., Erie, Pa.

Storage Batteries.

A handsome "Book of Curves," with many diagrams illustrating the operation of Chloride Accumulators in regulating the voltage and carrying loads in electric railway and lighting service. The Electric Storage Battery Co., Philadelphia.

Bulletin No. 74, illustrating and describing the application of storage batteries to isolated plants, as exemplified by the installation of Chloride Accumulators in the building of the Hastings' Sons Publishing Company, at Lynn, Mass. The Electric Storage Battery Co., Philadelphia.

Time Register.

Booklet devoted to the Hawley time register, which makes a graphic record of the working time of employees. The Hawley Time Register Co., Syracuse, N. Y.

Tools.

Illustrated catalogue and price list of twist drills, reamers, chucks, spring cotters, taps, flat spring and riveted keys, milling cutters and special tools, with tables of useful information and cable code. The Standard Tool Co., Cleveland.

Turrets.

Neat booklet with illustrated descriptions of many styles of turrets for lathes. Fay & Scott, Dexter, Me.

Ventilators.

A neat booklet with illustrated descriptions of Buffalo Improved Ventilators, and also of disk ventilating wheels, blowers and exhausters, forges, etc. Buffalo Forge Co., Buffalo.

Water Purification.

Neat booklet with illustrated descriptions of water-softening apparatus, industrial filters and hygienic filters for all industrial and other uses. Philadelphia Water Purification Co., Philadelphia.

Wattmeters.

Bulletin No. 1033, with illustrated description of integrating switchboard wattmeters for alternating current circuits. Fort Wayne Electric Works, Fort Wayne, Ind.

Wire Cloth.

Catalogue No. 21, a remarkably handsome and well-illustrated book devoted to the Tyler double-crimped wire cloth and screen, made of iron, steel, brass, copper and bronze wire for all purposes, and also to ornamental iron work. The W. S. Tyler Co., Cleveland.

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Catalogue for 1902, a large and handsome cloth-bound book of 620 pages, with remarkably well illustrated descriptions of a great variety of patented standard and special machines for working wood, manufactured exclusively by the H. B. Smith Machine Co., Smithville, N. J.

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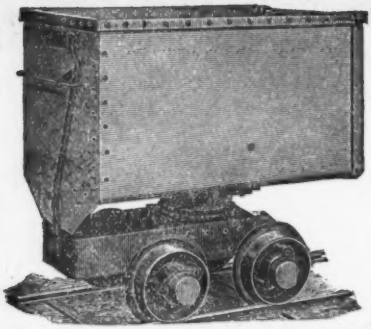

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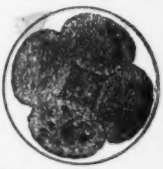

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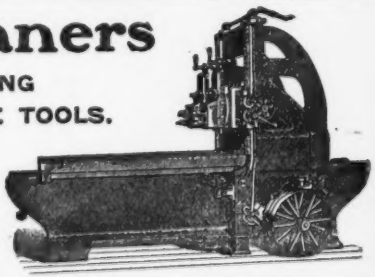

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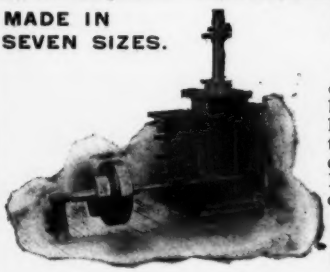

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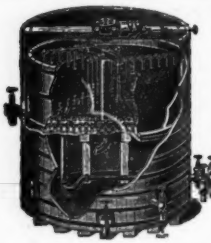

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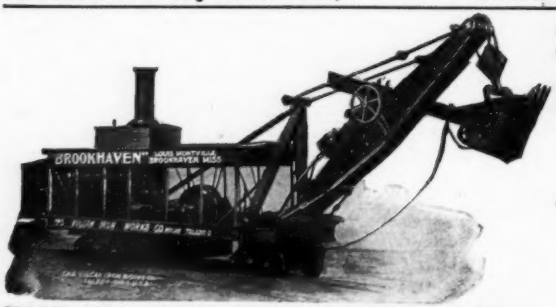

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AUTHORS AND PAPERS FOR SEPTEMBER, 1902.

WALTER M. McFARLAND *(The Naval Engineer of the Future)*—Born in 1859. Educated in public schools of Washington, D. C., and at U. S. Naval Academy, where he graduated as a cadet engineer in 1879. Served on naval vessels in various parts of the world. Was assistant professor of mechanical engineering at Cornell University, by detail from the Navy; secretary of division of marine engineering of International Engineering Congress, 1893; delegate from United States Navy Department to International Congress of Naval Architects and Marine Engineers, 1897. Was twice assistant to Admiral Melville, Engineer-in-Chief, U. S. Navy, the last time as principal assistant. Member of board to reorganize personnel of United States Navy. Was promoted to grade of chief engineer in 1898. Resigned from the Navy in 1899, to go with the Westinghouse Electric and Manufacturing Company, of which he is acting vice-president.

CHARLES M. JOHNSON *(The Doom of the Naval Engineer)*—Born 1838; studied engineering under the late John Chester Craven, locomotive engineer L. B. & S. C. Railway, and later entered works of John Scott Russell & Co., then engaged in finishing the Great Eastern; in 1859 entered Her Majesty's Navy as assistant engineer, his first sea-going ship being H. M. S. Forte, bearing the flag of Rear Admiral Sir Harry Keppel on the Cape and West Coast Stations, and afterwards on the South American station, 1860-1864. His subsequent employment was:—1865-1870, Arethusa and Wizard, Mediterranean station, with a few months as engineer-in-charge Gibraltar dockyard; 1873-1876, Thistle, China and Straits of Malacca station, specially promoted chief engineer for services in Perak expedition; 1876-1878, Cyclops, home and Channel service; 1879-1882, Swiftsure, preparing for foreign service, and 1882-1885, chief engineer H. M. S. Swiftsure, flag-ship of Admiral Sir Algernon Lyons, K. C. B., Pacific station; 1887-1890, superintending engineer Bermuda dockyard, with rank of inspector of machinery; 1891-1892, chief inspector of machinery to the Mediterranean fleet and in the island of Malta; 1892-1896, chief inspector of machinery of the fleet and dockyard reserves, and to commander-in-chief at Mount Wise, Devonport; 1896, retired.

W. M. BREWER *(Mining Resources and Mineral Industry of British Columbia)*—A mining engineer of many years' experience, at present practising in Victoria, British Columbia, and associated with the Northwestern Smelting and Refining Company at Vancouver Island. He has been in close touch with the mineral industry of the province for twelve years past.

C. R. D'ESTERRE *(The Paris-Vienna Motor-Car Races)*—A specialist in motor-car engineering, for some time associated with Mr. W. Worby Beaumont, whose articles on the Horseless Carriage Industry, Progress in Automobile Construction, and the 1,000-Miles Trials have appeared in preceding issues of this Magazine. Mr. D'Esterre's review is the result of his personal observation and study of the great Continental race.

GEORGE H. GIBSON *(High-Speed Interurban Electric Railways)*—Educated at the Engineering School of the University of Michigan, and then took up shop practice in the works of the Westinghouse

Electric & Manufacturing Company, Pittsburg, Pa.; this was followed by two years' experience on the editorial staff of "Engineering News," New York City, after which he returned to the Westinghouse company; has given especial attention to the subject of power generation and transmission, including the production and application of power gas; associate member of the American Institute of Electrical Engineers, and junior member of the American Society of Mechanical Engineers.

PERCY LONGMUIR *(Recording and Interpreting Foundry Costs)*—Served an apprenticeship in Sheffield to steel, iron, and brass founding; trained as a metallurgist in the laboratories of the Sheffield University College; possesses a wide experience of Scotch and English methods of foundry practice, and is an earnest student of American and Continental methods. A member of the American Foundrymen's Association, and of the Sheffield Society of Engineers and Metallurgists.

WILLIAM D. ENNIS *(Intensified Production and Industrial Investment)*—Born in New Jersey in the early '70's; apprenticed to the Rogers Locomotive Company; connected as engineer, salesman, and construction superintendent with various works, including the Passaic Rolling Mill Company, Walworth Construction & Supply Company, Consolidated Gas Company of New Jersey; graduate of the Stevens Institute of Technology; formerly engaged in private and associate practice in connection with the installation and economical operation of power plants; in 1900 located in the state of Washington at the instance of the Everett Pulp & Paper Company, engaging in the work of modernizing the power equipment of that and several allied industries. Returned to the eastern States under the same auspices, to become mechanical engineer of the reorganized American Linseed Company; recently appointed to the manufacturing management of that company's eastern mill district, comprising the linseed oil mills east of Chicago. A frequent contributor to technical literature, British, American and Continental, on subjects connected with steam and electrical engineering and engineering chemistry.

EGBERT P. WATSON *(Modern Practice in Boiler-Making Shops)*—Entered the Morgan Iron Works as apprentice, 1851, and afterwards employed in locomotive department of the Lowell, Mass., machine shop. On the closing of these works entered the employ of the Michigan Central R. R., and then followed the Lakes as a marine engineer for some years; returned to New York, entering the Novelty Iron Works, leaving this on invitation to join the editorial staff of the *Scientific American;* resigned this, on account of impaired health, to travel for a large steel-rail importing house; later established *The Mechanical Engineer* —afterwards called *The Engineer*—which enjoyed a certain popularity for nearly sixteen years. For three years past has devoted his attention to a water-tube boiler of his own invention. Frequent contributor to the technical press.

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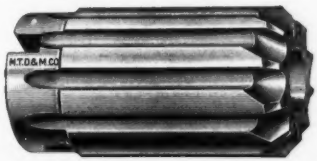

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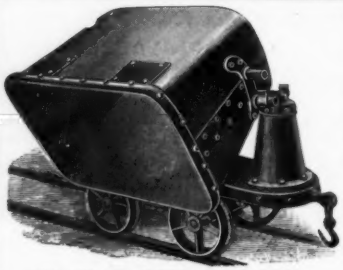

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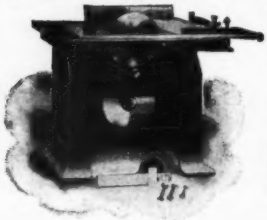

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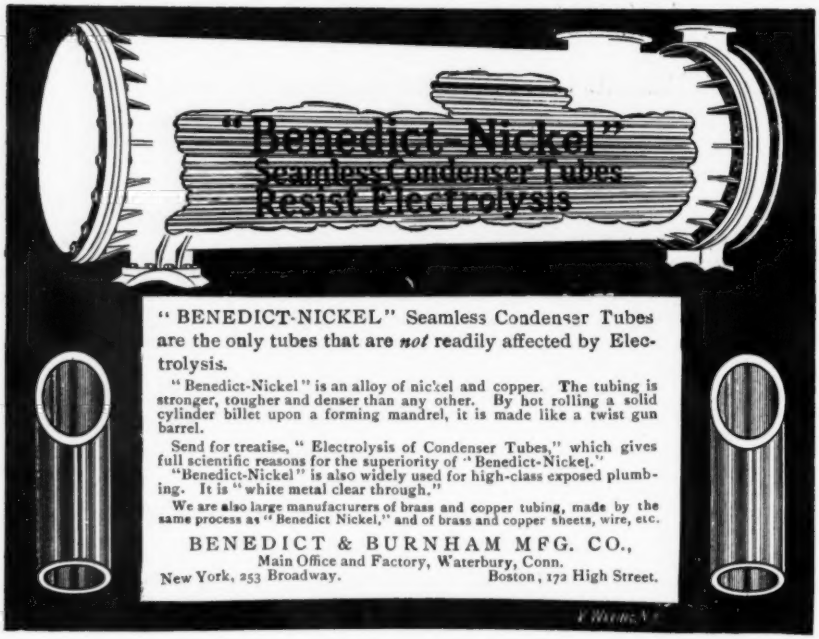

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It gives, first, a forceful review of the best and most useful articles which have appeared during the month in the entire technical press of Great Britain, the United States, and the Continent; second, a brief abstract of *every* technical article printed *anywhere* during the month—its author, title, substance, length, and place and date of appearance—all classified so that the concentrated essence of the literature of your specialty, whatever it may be, is presented to you at a glance.

The leading articles make THE ENGINEERING MAGAZINE invaluable; the Review and Index of the Engineering Press makes it indispensable.

A Buyers' Directory

THE ENGINEERING AND MACHINERY TRADES

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index on page 9.*

Acetylene Generators.
Power Specialty Co., 126 Liberty St., New York.

Accumulators, Electric.
Electric Storage Battery Co., Philadelphia, Pa.

Accumulators, Hydraulic.
Watson-Stillman Co., 204 E. 43rd St., New York.

Advertising.
Manufacturers' Advertising Bureau (Benj. R. Western), 126 Liberty St., New York.

Aerial Tramways.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 95 Liberty St., New York.
Trenton Iron Co., Trenton, N. J.

Air and Gas Compressors.
Allis-Chalmers Co., Chicago, Ill.
American Well Works, Aurora, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Blanchard Machine Co., Boston, Mass.
Christensen Engineering Co., Milwaukee, Wis.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air-Compress. Wks., 26 Cortlandt St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.
Hall Steam Pump Co., Pittsburg, Pa.
Henshaw, Bulkley & Co., San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.
Jacobson Machine Mfg. Co., Warren, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
J. Geo. Leyner, 1033 17th St., Denver, Colo.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
John H. McGowan Co., Cincinnati, Ohio.
McKiernan Drill Co., 120 Liberty St., New York.
Norwalk Iron Works, South Norwalk, Conn.
Pedrick & Ayer Co., Philadelphia, Pa.
Providence Engineering Works, Providence, R. I.
Rand Drill Co., 128 Broadway, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Union Steam Pump Co., Battle Creek, Mich.
Vulcan Iron Works, Wilkesbarre, Pa.
Henry R. Worthington, 114 Liberty St., New York.

Air Brakes.
Christensen Engineering Co., Milwaukee, Wis.
Westinghouse Air Brake Co., Pittsburg, Pa.

Air Drills.
J. Geo. Leyner, 1033 17th St., Denver, Colo.

Air Hoists.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Chicago Pneumatic Tool Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
Garry Iron & Steel Co., Cleveland, Ohio.
Hall Steam Pump Co., Pittsburg, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Northern Engineering Works, Detroit, Mich.
Pedrick & Ayer Co., Philadelphia, Pa.

Air Motors.
Chicago Pneumatic Tool Co., Chicago, Ill.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.

Ammeters.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Anti-Friction Metals.
Eastwood Wire Mfg. Co., Belleville, N. J.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
R. Poole & Son Co., Baltimore, Md.
Paul S. Reeves & Son, Philadelphia, Pa.

Arc Lamps—SEE LAMPS, ELECTRIC.

Assayers' and Chemists' Supplies.
F. W. Braun & Co., Los Angeles, Cal.

Automatic Circuit Breakers.
The Cutter Co., Philadelphia, Pa.

Automatic Machines.
Potter & Johnston, Pawtucket, R. I.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Automobiles.
Electric Vehicle Co., 100 B'way, N. Y.
Locomobile Co. of America, 7 E. 42d St., New York.

Auxiliary Engines.
Buffalo Forge Co., Buffalo, N. Y.

Axles.
Bethlehem Steel Co., So. Bethlehem, Pa.

Ballast Unloaders.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.

Ball Bearings.
Ball Bearing Co., Philadelphia, Pa.

Ballcocks.
Julian D'Este Company, 24 Canal St., Boston, Mass.

Belt Dressing (Waterproof).
Jos. Dixon Crucible Co., Jersey City, N. J.
Chas. A. Schieren & Co., 45-51 Ferry St., N. Y.

Belting.
Aultman Company, Canton, Ohio.
Boston Belting Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Engineering Co., Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Chas. A. Schieren & Co., 45-51 Ferry St., N. Y.

Belt Lacing.
Bristol Co., Waterbury, Conn.
Chas. A. Schieren & Co., 45-51 Ferry St., N. Y.

Bending Rolls.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Bethlehem Steel Co., So. Bethlehem, Pa.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, Ohio.
Niagara Machine & Tool Works, Buffalo, N. Y.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

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Blast Furnaces.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Wellman-Seaver-Morgan Engng. Co., Cleveland, O.

Blowers.
American Blower Co., Detroit, Mich.
American Gas Furnace Co., 23 John St., New York.
Buffalo Forge Co., Buffalo, N. Y.
Henshaw, Bulkley & Co., San Francisco, Cal.
Massachusetts Fan Co., 53 State St., Boston, Mass.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Boiler Fronts and Fittings.
John Simmons Co., 110 Centre St., New York.
Vulcan Iron Works, Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Boiler Compounds
Dearborn Drug & Chemical Works, 29 Rialto, Chicago, Ill.
John Simmons Co., 110 Centre St., New York.
Thos. H. Warley & Co., Philadelphia, Pa.

Boiler Inspectors.
Hartford S. B. I. & Ins. Co., Hartford, Conn.

Boiler-Makers' Tools.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, Ohio.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
Stow Flexible Shaft Co., Philadelphia, Pa.

Boilers—SEE ALSO WATER-TUBE BOILERS.
Allis-Chalmers Co., Chicago, Ill.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
Babcock & Wilcox Co., 85 Liberty St., New York.
Chandler & Taylor Co., Indianapolis, Ind.
Denver Engineering Works, Denver, Colo
Henshaw, Bulkley & Co., San Francisco, Cal.
Keystone Driller Co., Beaver Falls, Pa.
Marine Iron Works, Chicago, Ill.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
Herman Nieter, 39 Cortlandt St., New York.
Riter-Conley Mfg. Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.
Star Drilling Machine Co., Akron, Ohio.
The Stirling Co., Chicago, Ill.

Boiler Tube Cleaners.
Wm. B. Pierce Co., Buffalo, N. Y.

Books.
Theo. Audel & Co., 63 Fifth Ave., New York.
Association of Engineering Societies, Phila., Pa.
Henry Carey Baird & Co., 810 Walnut St., Philadelphia, Pa.
Eng'g Magazine Press, 120-122 Liberty St., N. Y.

Boring Mills.
American Tool Works Co., Cincinnati, Ohio.
Baush Machine Tool Co., Springfield, Mass.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Niles Tool Works Co., Hamilton, Ohio.
Pond Machine Tool Co., Plainfield, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Box Makers' Machinery.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Brazing Materials.
American Ferrofix Co., 29 Broad St., New York.

Brick.
Henry Maurer & Son, 420 E. 23d St., New York.

Brick and Tile Machinery.
American Blower Co., Detroit, Mich.
Henshaw, Bulkley & Co., San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
Massachusetts Fan Co., Waltham, Mass.
Vulcan Iron Works Co., Toledo, Ohio.

Briquetting Machinery.
Henry S. Mould Co., Pittsburg, Pa.

Buckets, Automatic.
Hayward Co., 97 Cedar St., New York.

Cable-Railway Machinery.
Allis-Chalmers Co., Chicago, Ill.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Hazard Mfg. Co., Wilkes-Barre, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
R. Poole & Son Co., Baltimore, Md.

Cables, Electric and Submarine.
General Electric Co., New York.
Hazard Mfg. Co., Wilkes-Barre, Pa.
John A. Roebling's Sons Co., Trenton, N. J.
Sprague Electric Co., 527 W. 34th St., New York.
Western Electric Company Chicago, Ill.

Cableways—Steam and Electric.
Lidgerwood Mfg. Co., 96 Liberty St., New York.

Cables, Wire.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calculating Machines.
Calculagraph Co., 9-13 Maiden Lane, New York.
Carlton Mfg. Co., 76 Franklin St., New York.

Card Index Files.
Shaw-Walker Co., Muskegon, Mich.
The Fred Macey Co., Grand Rapids, Mich.
Vetter Desk Co., Rochester, N. Y.

Car Shop Machinery.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, Ohio.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.

Carriage and Wagon Machinery.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Cast Iron Pipe—SEE PIPE.

Castings, Iron, Steel and Brass.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Bethlehem Steel Co., So. Bethlehem, Pa.
Denver Engineering Works, Denver, Colo.
Stanley G. Flagg & Co., Philadelphia, Pa.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Jeffrey Mfg. Co., Columbus, Ohio.
Maryland Steel Co., Sparrows Point, Md.
J. S. Mundy, Newark, N. J.
Pennsylvania Steel Co., Steelton, Pa.
Paul S. Reeves & Son, Philadelphia, Pa.
John Simmons Co., 110 Centre St., New York.
S. Morgan Smith Co., York, Pa.
E. M. Shaw, Providence, R. I.
Southwark Foundry & Machine Co., Phila., Pa.
Walworth Manufacturing Co., Boston, Mass.

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Cement Machinery.

Allis-Chalmers Co., Chicago, Ill.
Bethlehem Fdy. & Mch. Co., South Bethlehem, Pa.
H. W. Caldwell & Sons Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Vulcan Iron Works Co., Toledo, Ohio.

Cement – Portland.

American Cement Co., Philadelphia, Pa.
Atlas Portland Cement Co., 143 Liberty St., N. Y.
Kelley Island Lime & Transport Co., Cleveland, O.
Lawrence Cement Co., 1 Broadway, New York.

Chain Belting.

Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
J. G. Speidel, Reading, Pa.

Chemicals.

American Ferrofix Co., 20 Broad St., New York.
F. W. Braun & Co., Los Angeles, Cal.
Roessler & Hasslacher Chem. Co., 100 William S., N. Y.

Chemical Works Machinery.

Atlantic Works, East Boston, Mass.

Chemists.

Chas. Catlett, Staunton, Va.
L. B. Darling, 79 Sabin St., Providence, R. I.
Robt. W. Hunt & Co., Chicago, Ill.

Chucks

Potter & Johnston, Pawtucket, R. I.

Circuit Breakers.

Cutter Co., 19th and Hamilton Sts., Philadelphia.

Clay-Working Machinery.

American Blower Co., Detroit, Mich.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Vulcan Iron Works, Toledo, Ohio.

Clocks—Time Recording.

American Watchman's Time Detector Co., 234 Broadway, New York.

Clutch Pulleys.

H. W. Caldwell & Sons Co., Chicago, Ill.
Jacobson Machine Mfg. Co., Warren, Pa.

Coal and Ashes-Handling Machinery.

Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
The Hayward Co., 97 Cedar St., New York.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Coal-Mining Machinery.

Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York
Buffalo Forge Co., Buffalo, N. Y.
Denver Engineering Works, Denver, Colo.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Triumph Electric Co., Cincinnati, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coal Screens.

Allis-Chalmers Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.

Concentrating Tables.

Mine & Smelter Supply Co., Denver, Col.

Concentrators.

Denver Engineering Works, Denver, Colo.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.

Condensers.

Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Southwark Foundry & Machine Co., Phila., Pa.
Union Steam Pump Co., Battle Creek, Mich.
Henry R. Worthington, 114 Liberty St., New York.

Continuous Rolling Mills.

Morgan Construction Co., Worcester, Mass.

Conveying Machinery.

Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Frick Company, Waynesboro, Pa.
The Hayward Co., 97 Cedar St., New York.
Heyl & Patterson, Pittsburg, Pa.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Mine & Smelter Supply Co., Denver, Col.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Cooling Towers.

Alberger Condenser Co., 95 Liberty St., New York.

Copper.

Orford Copper Co., 37 Wall St., New York.

Core Ovens.

Millett Core Oven Co., Brightwood, Mass.

Cost Systems.

Gunn & Richards, 25 Pine St., New York.
Hugo Diemer, Lawrence, Kansas.

Cranes.

American Hoist & Derrick Co., St. Paul, Minn.
Brown Hoisting Mchy. Co., Inc., Cleveland, O.
Browning Engineering Co., Cleveland, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Denver Engineering Works, Denver, Colo.
Garry Iron & Steel Co., Cleveland, Ohio.
Hayward Co., 97 Cedar St., New York.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Pedrick & Ayer Co., Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. Sellers & Co., Philadelphia, Pa.

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Shaw Electric Crane Co., Muskegon, Mich.
J. G. Speidel, Reading, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Crucibles.

F. W. Braun & Co., Los Angeles, Cal.
R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Crushers—Ore, Phosphate, Rock.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
F. W. Braun & Co., Los Angeles, Cal.
Denver Engineering Works, Denver, Colo.
Jeffrey Mfg. Co., Columbus, Ohio.
F. L. Smidth & Co., 66 Malden Lane, New York.
Sturtevant Mill Co., Boston, Mass.

Cupel Machines.

F. W. Braun & Co., Los Angeles, Cal.

Cupolas.

Northern Engineering Works, Detroit, Mich.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Cutters, Milling.

Brown & Sharpe Mfg. Co., Providence, R. I.

Diamond Drills.

American Diamond Rock Drill Co., 120 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 128 Broadway, New York.

Digesters.

Atlantic Works, East Boston, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Draw Benches, Wire.

Trenton Iron Co., Trenton, N. J.

Draught Gauges.

Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Draughtsmen's Instruments and Materials.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Eugene Dietzgen Co., 181 Monroe St., Chicago, Ill.
Keuffel & Esser Co., New York.
Queen & Co., Inc., Philadelphia, Pa.

Dredges—SEE EXCAVATIONS.

Drilling Machines.

American Tool Works Co., Cincinnati, Ohio.
Baush Machine Tool Co., Springfield, Mass.
H. G. Barr, Worcester, Mass.
W. F. & John Barnes Co., Rockford, Ill.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Pneumatic Tool Co., Chicago, Ill.
Thos. H. Dallett & Co., Philadelphia, Pa.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Niles Tool Works Co., Hamilton, Ohio.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pond Machine Tool Co., Plainfield, N. J.
Francis Reed Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drills—Rock and Coal.

American Diamond Rock Drill Co., 95 Liberty St., New York.
H. D. Crippen, 52 B'way, N. Y.
Clayton Air Compress. Wks., 120 Liberty St., N.Y.
Davis Calyx Drill Co., 128 Broadway, New York.
Denver Engineering Works, Denver, Colo.
Hall Steam Pump Co., Pittsburg, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Keystone Driller Co., Beaver Falls, Pa.
J. Geo. Leyner, 1033 17th St., Denver, Colo.
McKiernan Drill Co., 120 Liberty St., New York.
Mine & Smelter Supply Co., Denver, Col.
Rand Drill Co., 128 Broadway, New York.
Star Drilling Machine Co., Akron, Ohio.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Massachusetts Fan Co., Waltham, Mass.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Dynamos.

American Engine Co., Bound Brook, N. J.
Chas. J. Bogue, 217 Centre St., New York.
Crocker-Wheeler Co., Ampere, N. J.
C & C Electric Co., 143 Liberty St., New York.
General Electric Co., New York.
Guarantee Electric Co., Chicago, Ill.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Western Electric Company, Chicago, Ill.
Westinghouse Electric & Mfg. Co. Pittsburg, Pa.

Ejectors.

Hancock Inspirator Co., 85 Liberty St., New York.
Hayden & Derby Mfg. Co., New York.
Watson & McDaniel Co., Philadelphia, Pa.

Electric Hoists.

Denver Engineering Works, Denver, Colo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.

Electric Heating Apparatus.

Simplex Electric Heating Co., Cambridgeport, Mass.

Electrical Machinery and Supplies.

Akron Electrical Mfg. Co., Akron, Ohio.
American Engine Co., Bound Brook, N. J.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Bristol Co., Waterbury, Conn.
C & C Electric Co., 143 Liberty St., New York.
Crocker-Wheeler Co., Ampere, N. J.
Deane Steam Pump Co., Holyoke, Mass.
General Electric Co., New York.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
H. W. Johns Mfg. Co., 100 William St., New York.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Massachusetts Fan Co., Waltham, Mass.
Wm. E. Quimby, Inc., 86 Liberty St., New York.
Snow Steam Pump Works, Buffalo, N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Western Electric Company, Chicago, Ill.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.
Henry R. Worthington, 114 Liberty St., New York.

Elevators.

American Tool & Machine Co., Boston, Mass.
Aultman Co., Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
R. Poole & Son Co., Baltimore, Md.
J. G. Speidel, Reading, Pa.
Triumph Electric Co., Cincinnati, Ohio.

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Emery Wheels.

Stow Flexible Shaft Co., Philadelphia, Pa.

Engineers, Civil.

Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill.
Sydney F. Reynolds, Torrey, Pa.
Samuel Storrow, Los Angeles, Cal.

Engineers, Electrical.

Clay Belsley, Peoria, Ill.
Iron City Engineering Co., Pittsburg, Pa.
Robt. McF. Doble, 314 Hayward Bldg., San Francisco, Cal.
Sydney F. Reynolds, Torrey, Pa.

Engineers, Mechanical.

Wm. S. Aldrich, Potsdam, N. Y.
Clay Belsley, Peoria, Ill.
Geo. M. Brill, Marquette Bldg., Chicago, Ill.
Robt. McF. Doble, 314 Hayward Bldg., San Francisco, Cal.
Alfred G. Heggem, Massillon, Ohio.
Holt & Schober, 378 Bourse, Philadelphia, Pa.
S. V. Huber & Co., Pittsburg, Pa.
Julian Kennedy, Pittsburg, Pa.
Walter Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Pittsburg, Pa.
Milton L. Oglesby, 429 Atlas Block, Salt Lake City, Utah.
C. L. Redfield, 1563 Monadnock Block, Chicago, Ill.
Sydney F. Reynolds, Torrey, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Wellman-Seaver-Morgan Engineering Co., Cleveland, Ohio.
William M. Brewer, Vancouver, B. C.

Engineers, Mining.

William M. Brewer, Vancouver, B. C.
Chas. Catlett, Staunton, Va.
John S. Cummings, Tunnelton, W. Va.
L. B. Darling, Providence, R. I.
W. Dusedau, 1732 Blake St., Denver, Colo.
Chas. F. Howe, Gainesville, Ga.
Bernard MacDonald, Rossland, B. C.
Milton L. Oglesby, 429 Atlas Block, Salt Lake City, Utah.
Sydney F. Reynolds, Torrey, Pa.
Samuel Storrow, Los Angeles, Cal.

Engines, Blowing.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
Southwark Foundry & Machine Co., Phila., Pa.

Engines—Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Gas Engine & Power Co., Morris Heights, N. Y.
Lozier Motor Co., Plattsburg, N. Y.
Machinery & Electrical Co., Los Angeles, Cal.
Northern Engineering Works, Detroit, Mich.
Charles L. Seabury & Co., Morris Heights, N. Y.
Struthers, Wells & Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Gas Engine & Power Co., Morris Heights, N. Y.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Marine Iron Works, Chicago, Ill.
Charles L. Seabury & Co., Morris Heights, N. Y.

Engines, Stationary.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J.
American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Ball Engine Co., Erie, Pa.
Ball & Wood Co., 120 Liberty St., New York.
A. F. Bartlett & Co., Saginaw, Mich.
Bradley Mfg. Co., Allegheny, Pa.
Brown Corliss Engine Co., Milwaukee, Wis.
Buffalo Forge Co., Buffalo, N. Y.
Chandler & Taylor Co., Indianapolis, Ind.
Denver Engineering Works, Denver, Colo.
Frick Company, Waynesboro, Pa.
Harrisburg Fdy. & Mch. Co., Harrisburg, Pa.
Henshaw, Bulkley & Co., San Francisco, Cal.
Hooven, Owens, Rentschler Co., Hamilton, Ohio.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
Frank M. Pierce Engineering Co., 135 B'way, N. Y.
Providence Engineering Works, Providence, R. I.
Southwark Foundry & Machine Co., Phila., Pa.
Star Drilling Machine Co., Akron, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
The William Tod Co., Youngstown, Ohio.

Engravers.

A. Mugford, 120 Liberty St., New York.
C. P. Zacher & Co., 221 Fifth Ave., Chicago, Ill.

Excavators.

Atlantic, Gulf & Pacific Co., Park Row Bldg., N. Y.
Aultman Company, Canton, Ohio.
Bucyrus Co., So. Milwaukee, Wis.
The Hayward Co., 97 Cedar St., New York.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis Mo.
Marion Steam Shovel Co., Marion, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Exhaust Heads.

Buffalo Forge Co., Buffalo, N. Y.
Direct Separator Co., Syracuse, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

Fans, Ventilating.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Massachusetts Fan Co., Waltham, Mass.
Monongahela Mfg. Co., Monongahela, Pa.
Power Specialty Co., 126 Liberty St., New York.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Western Electric Company, Chicago, Ill.

Feed-Water Heaters and Purifiers.

Allis-Chalmers Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
Goubert Mfg. Co., 85 Liberty St., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Providence Engineering Works, Providence, R. I.
Ross Valve Co., Troy, N. Y.
Stewart Heater Co., Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Warren Webster & Co., Camden, N. J.

Ferrofix.

American Ferrofix Co., 20 Broad St., New York.

Fertilizer Machinery.

Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.

Files and Rasps.

G. & H. Barnett Co., Philadelphia, Pa.

Filters.

New York Cont. Jewell Filt. Co., 15 Broad St., N. Y.
Pittsburgh Filter Mfg. Co., Pittsburgh, Pa.

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Filters, Oil.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Fire Brick.
Henry Maurer & Son, 420 East 23d St., New York.

Fireproof Building Materials.
Henry Maurer & Son, 420 East 23d St., New York.
National Fireproofing Co., Pittsburg, Pa.

Fire Pumps.
American Fire Engine Co., Seneca Falls, N. Y.

Flanges.
Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

Flexible Shafts.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.
T. H. Brooks & Co., Cleveland, Ohio.

Fluxes.
American Ferroux Co., 20 Broad St., New York.

Fly Wheels.
Allis-Chalmers Co., Chicago, Ill.
Dodge Mfg. Co. Mishawaka, Ind.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Forges.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Forgings, Iron and Steel.
Chester B. Albree, Allegheny, Pa.
Keystone Drop Forge Works, Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Pennsylvania Steel Co., Steelton, Pa.
Wyman & Gordon, Worcester, Mass.

Foundry Equipment.
Blanchard Machine Co., Boston, Mass.
Arthur Koppel, 68 Broad St., New York.
Millett Core Oven Co., Brightwood, Mass.
Northern Engineering Works, Detroit, Mich.
Pedrick & Ayer Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.

Friction Clutches.
American Tool & Machine Co., Boston, Mass.
H. W. Caldwell & Sons Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Coil Clutch Mfg. Co., Inc., 45 Broadway, New York.
Dodge Mfg. Co., Mishawaka, Ind.
Eastern Machinery Co., New Haven, Conn.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Fuel Economizers.
Green Fuel Economizer Co., Matteawan, N. Y.
Providence Engineering Works, Providence, R. I.
Steam Boiler Equipment Co., 30 W. Houston St., New York.

Fuel Gas Producer.
Loomis-Pettibone Co., 52 Broadway, New York.

Furnace Builders.
American Gas Furnace Co., 23 John St., New York.
Buffalo Forge Co., Buffalo, N. Y.
Continental Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Julian Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Rockwell Engineering Co., 26 Cortlandt St., N. Y.
Wellman-Seaver-Morgan Eng'ng Co., Cleveland, O.

Furnaces, Assayers.
F. W. Braun & Co., Los Angeles, Cal.

Gage Cock.
Phillips Company, 257 Atlantic Ave., Boston, Mass.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Gages—Pressure, Steam, Water, etc.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
John Simmons Co., 110 Centre St., New York.
Star Brass Mfg. Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Galvanizing.
John Simmons Co., 110 Centre St., New York.
U. S. Electro-Galvanizing Co., 348 Broadway, N. Y.

Gas Exhausters.
American Blower Co., Detroit, Mich.
B. F. Sturtevant Co., Boston, Mass.

Gas Holders and Regulators.
Continent. Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Jacobson Machine Mfg. Co., Warren, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Gaskets, Metallic.
H. W. Johns-Manville Co., 100 William St., N. Y.
McCord & Co., 107 Broadway, New York.

Gas Machines and Generators.
American Gas Furnace Co., 23 John St., New York.
Duff's Patents Co., Pittsburg, Pa.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Morgan Construction Co., Worcester, Mass.
R. D. Wood & Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gas Soldering Furnaces.
Jacobson Machine Mfg. Co., Warren, Pa.

Gear Cutting Machines.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Gould & Eberhardt, Newark, N. J.
R. D. Nuttall Co., Pittsburg, Pa.

Gearing.
Allis-Chalmers Co., Chicago, Ill.
Hugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Boston Gear Works, Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Denver Engineering Works, Denver, Colo.
Dodge Mfg. Co., Mishawaka, Ind.

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Gould & Eberhardt, Newark, N. J.
Jacobson Mch. Mfg. Co., Warren, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Morse Elevator Works, Philadelphia, Pa.
J. S. Mundy, Newark, N. J.
New Process Rawhide Co., Syracuse, N. Y.
R. D. Nuttall Co., Pittsburg, Pa.
R. Poole & Son Co., Baltimore, Md.
William Sellers & Co., Inc., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Stow Flexible Shaft Co., Philadelphia, Pa.

Grain Elevator Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Graphite.

Jos. Dixon Crucible Co., Jersey City, N. J.

Greases.

Keystone Lubricating Co., Philadelphia, Pa.

Grinding and Polishing Machinery.

American Tool Works Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Diamond Machine Co., Providence, R. I.
Dodge Mfg. Co. Mishawaka, Ind.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Iroquois Machine Co., 150 Nassau St., New York.
Landis Tool Co., Waynesboro, Pa.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Stow Flexible Shaft Co., Philadelphia, Pa.
Washburn Shops, Worcester, Mass.

Handpower Crabs and Winches.

American Hoist & Derrick Co., St. Paul, Minn

Hangers—SEE PULLEYS.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Hayden & Derby Mfg. Co., New York.
Henshaw, Bulkley & Co., San Francisco, Cal.
Massachusetts Fan Co., Waltham, Mass.
Power Specialty Co., 126 Liberty St., New York.
John Simmons Co., 110 Centre St., New York.
Sprague Electric Co., 527 W. 34th St., New York.
H. B. Smith Co., 137 Centre St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Mfg. Co., Boston, Mass.

Hoisting Engines and Machinery.

Allis-Chalmers Co., Chicago, Ill.
American Hoist & Derrick Co., St. Paul, Minn.
Aultman Company, Canton, Ohio.
Brown Hoisting Machinery Co., Inc., Cleveland, O.
Browning Engineering Co., Cleveland, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
Denver Engineering Works, Denver, Colo.
The Hayward Co., 97 Cedar St., New York.
Henshaw, Bulkley & Co., San Francisco, Cal.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Machinery & Electrical Co., Los Angeles, Cal.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
John A. Mead Mfg. Co., 11 Broadway, New York.
Monongahela Mfg. Co., Monongahela, Pa.
J. S. Mundy, Newark, N. J.
Niles Tool Works Co., Hamilton, Ohio.
Northern Engineering Works, Detroit, Mich.
Providence Engineering Works, Providence, R. I.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works, Wilkesbarre, Pa.
Webster, Camp & Lane Machine Co., Akron, O.

Hollow Chisel Mortisers.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Hose.

Boston Belting Co., Boston, Mass.

Hydraulic Machinery.

Christiana Machine Co., Christiana, Pa.
John H. McGowan Co., Cincinnati, Ohio.
S. Morgan Smith Co., York, Pa.
R. Poole & Son Co., Baltimore, Md.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Union Steam Pump Co., Battle Creek, Mich.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Rams.

Niagara Hydraulic Engine Co., Chester, Pa.
Power Specialty Co., 126 Liberty St., New York.

Ice-Making and Refrigerating Machinery.

Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Frick Company, Waynesboro, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
H. B. Roelker, 41 Maiden Lane, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Henry R. Worthington, 114 Liberty St., New York

Incandescent Lamps—SEE LAMPS, ELECTRIC.

Injectors.

Hayden & Derby Mfg. Co., New York.
The Lunkenheimer Co., Cincinnati, Ohio.
John Simmons Co., 110 Centre St., New York.
Wm. Sellers & Co., Philadelphia, Pa.

Inspirators.

Hancock Inspirator Co., 85 Liberty St., New York.

Insulated Wire.

General Electric Co., New York.
Hazard Mfg. Co., Wilkes-Barre, Pa.
John A. Roebling's Sons Co., Trenton, N. J.
Sprague Electric Co., 527 W. 34th St., New York.

Insulating Varnish.

Sterling Varnish Co., Pittsburg, Pa.

Jacks.

Duff Mfg. Co., Pittsburg, Pa.

Jet Apparatus.

Hancock Inspirator Co., 85 Liberty St., New York.
Hayden & Derby Mfg. Co., New York.

Keyseaters.

Mitts & Merrill, Saginaw, Mich.

Kilns.

Atlantic Works, East Boston, Mass.

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Laboratory Supplies.

F. W. Braun & Co., Los Angeles, Cal.

Lamps, Electric.

General Electric Co., New York.
General Incandescent Lamp Co., Cleveland, Ohio.
Regina Arc Lamp Works, Cologne, Germany.
Sterling Electrical Mfg. Co., Warren, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Western Electric Company, Chicago, Ill.

Lathe Pans.

New Britain Machine Co., New Britain, Conn.

Lathes.

American Tool & Machine Co., Boston, Mass.
American Tool Works Co., Cincinnati, Ohio.
W. F. & John Barnes Co., Rockford, Ill.
Cincinnati Milling Machine Co., Cincinnati, O.
Diamond Machine Co., Providence, R. I.
A. Garrison Foundry Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Potter & Johnston, Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Launches.

Lozier Motor Co., Plattsburg, N. Y.

Leather, Hydraulic, Valve and Pump.

Chas. A. Schieren & Co., 45-51 Ferry St., New York.

Light Draft Steam Vessels.

Marine Iron Works, Chicago, Ill.

Light Railways.

Dodge Mfg. Co., Mishawaka, Ind.
C. W. Hunt Co., West New Brighton, New York.
Arthur Koppel, 68 Broad St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Whiting Foundry Equipment Co., Harvey, Ill.

Lockers.

Merritt & Co., Philadelphia, Pa.
Narragansett Machinery Co., Providence, R. I.

Locomotives, Steam.

American Locomotive Co., 25 Broad St., New York.
Baldwin Locomotive Works, Philadelphia, Pa.
Lima Locomotive & Machine Co., Lima, Ohio.
H. K. Porter Co., Pittsburg, Pa.
Vulcan Iron Works, Wilkesbarre, Pa.

Locomotives, Electric.

Baldwin Locomotive Works, Philadelphia, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
H. K. Porter Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.
Graphite Lubricating Co., Bound Brook, N. J.
Keystone Lubricating Co., Philadelphia, Pa.
Thos. H. Warley & Co., Philadelphia, Pa.

Lubricators.

Phillips Company, 257 Atlantic Ave., Boston, Mass.

Machine Repairers.

American Ferrofix Co., 20 Broad St., New York.

Machinery Salvage.

American Ferrofix Co., 20 Broad St., New York.

Machine Tools and Supplies.

Acme Machinery Co., Cleveland, Ohio.
American Tool & Machine Co., Boston, Mass.
American Tool Works Co., Cincinnati, O.
W. F. & John Barnes Co., Rockford, Ill.
Baush Machine Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Crane Co., Chicago, Ill.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Hilles & Jones Co., Wilmington, Del.
Jones & Lamson Machine Co., Springfield, Vt.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Niles Tool Works Co., Hamilton, O.
Pearson Machine Co., Chicago, Ill.
Pond Machine Tool Co., Plainfield, N. J.
Potter & Johnston, Pawtucket, R. I.
Power Specialty Co., 126 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Walworth Manufacturing Co., Boston, Mass
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Whitcomb Mfg. Co., Worcester, Mass.

Machinists' Small Tools.

Acme Machinery Co., Cleveland, Ohio.
American Tool Works Co., Cincinnati, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Mechanical Draft.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Massachusetts Fan Co., Waltham, Mass.
Power Specialty Co., 126 Liberty St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Metal Saw Machinery.

The Q & C Co., Chicago, Ill.

Meters, Electric.

General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Milling Machines.

Adams Company, Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Kempsmith Mfg. Co., Milwaukee, Wis.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Mill Supplies.

Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Mine Cars.

Allis-Chalmers Co., Chicago.
Denver Engineering Works, Denver, Colo.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
Monongahela Mfg. Co., Monongahela, Pa.
Watt Mining Car Wheel Co., Barnesville, Ohio.

Mining Machinery.

Allis-Chalmers Co., Chicago, Ill.
American Diamond Rock Drill Co., 95 Liberty St., New York.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.

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Davis Calyx Drill Co., 128 Broadway, New York.
Deane Steam Pump Co., Holyoke, Mass.
Denver Engineering Works, Denver, Colo.
Eastwood Wire Mfg. Co., Belleville, N. J.
General Electric Co., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Keystone Driller Co., Beaver Falls, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
J. Geo. Leyner, 1033 17th St., Denver, Colo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Marion Steam Shovel Co., Marion, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
McKiernan Drill Co., 120 Liberty St., New York.
Monongahela Mfg. Co., Monongahela, Pa.
J. S. Mundy, Newark, N. J.
Norwalk Iron Works, South Norwalk, Conn.
Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Providence Engineering Works, Providence, R. I.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Trenton Iron Works Co., Trenton, N. J.
Union Steam Pump Co., Battle Creek, Mich.
Vulcan Iron Works Co., Toledo, Ohio.
Watt Mining Car Wheel Co., Barnesville, Ohio.
Webster, Camp & Lane Machine Co., Akron, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Henry R. Worthington, 114 Liberty St., New York.

Mining Screens—SEE SCREENS.

Motors, Electric.

Akron Electrical Mfg. Co., Akron, Ohio.
American Engine Co., Bound Brook, N. J.
Chas. J. Bogue, 217 Centre St., New York.
C & C Electric Co., 145 Liberty St., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Guarantee Electric Co., Chicago, Ill.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Western Electric Company, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Moulding Machines.

Tabor Mfg. Co., 1742 Hamilton St Philadelphia, Pa.

Multiple Spindle Drills.

Baush Machine Tool Co., Springfield, Mass.

Naphtha Gas Machines.

American Gas Furnace Co., 23 John St., New York.

Naphtha Launches.

Gas Engine & Power Co., Morris Heights, N. Y.
Charles L. Seabury & Co., Morris Heights, N. Y.

Nickel.

Benedict & Burnham Mfg. Co., Waterbury, Conn.
Orford Copper Co., 37 Wall St., New York.

Nickel-Steel.

Bethlehem Steel Co., So. Bethlehem, Pa.

Nozzles.

R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Oil.

Keystone Lubricating Co., Philadelphia, Pa.
Thomas C. Warley, Philadelphia, Pa.

Oil Cups.

Phillips Company, 257 Atlantic Ave., Boston, Mass.

Oil Burner.

C. A. Hammel, 120 W. Fifth St., Los Angeles, Cal.

Oil (Furnace) Burning Appliances.

Rockwell Engineering Co., 26 Cortlandt St., N. Y.

Open Hearth Furnaces.

G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.

Ore-Roasting Machinery.

Allis-Chalmers Co., Chicago, Ill.
Denver Engineering Works, Denver, Colo.

Packing.

Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., New York.
Geo. W. Knowlton Rubber Co., Boston, Mass.
A. Leschen & Sons Rope Co., St. Louis, Mo.

Paints and Varnishes.

Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.

Paper-Mill Machinery.

Aultman Company, Canton, Ohio.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Snow Steam Pump Works, Buffalo, N. Y.
Henry R. Worthington, 114 Liberty St., New York.

Patent Attorneys.

Wm. N. Cromwell, 1003 F St., N. W., Washington, D. C.
C. A. Dieterich, 229 Broadway, New York.
Evans, Wilkins & Co., Evans Building, Washington, D. C.

Pattern-Makers' Machinery.

American Machinery Co., Grand Rapids, Mich.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Perforated Metal.

Allis-Chalmers Co., Chicago, Ill.
Robt. Aitchinson Perforated Metal Co., Chicago, Ill.
H. W. Caldwell & Sons Co., Chicago, Ill.
Hendrick Mfg. Co., Carbondale, Pa.

Pinions.

A. Garrison Foundry Co., Pittsburg, Pa.

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Pipe.
American Spiral Pipe Works, Chicago, Ill.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Pipe, Cast-Iron.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Pipe Coverings.
Michigan Pipe Co., Bay City, Mich.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Pipe-Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.
Cox & Sons Company, Bridgeton, N. J.
Merrell Mfg. Co., Toledo, Ohio.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.
Kelly & Jones Co., Greensburg, Pa.
John Simmons Co., 110 Centre St., New York.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Walworth Manufacturing Co., Boston, Mass.

Placer Testing Machinery.
Keystone Driller Co., Beaver Falls, Pa.

Pipe Vises.
John Simmons Co., 110 Centre St., New York.

Planers.
American Tool Works Co., Cincinnati, Ohio.
E. C. Bartlett, Boston, Mass.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Whitcomb Mfg. Co., Worcester, Mass.
W. A. Wilson, Rochester, N. Y.

Planing Mill Machinery.
Buffalo Forge Co., Buffalo, N. Y.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Platinum Ware.
F. W. Braun & Co., Los Angeles, Cal.
J. C. Entriken, Malvern, Pa.

Pneumatic Concentrator.
General Concentrates Co., 128 Broadway, New York.

Pneumatic Tools.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compress. Wks., 26 Cortlandt St., N.Y.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
The Q & C Co., Chicago, Ill.

Pop Safety Valves.
Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Star Brass Mfg. Co., Boston, Mass.

Power Hammers.
H. G. Barr, Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Power-Transmission Machinery.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Dodge Mfg. Co., Mishawaka, Ind.
General Electric Co., New York.
Hayward Co., 97 Cedar St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Niles Tool Works Co., New York, N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
S. Morgan Smith Co., York, Pa.
Sprague Electric Co., 527 W. 34th St., New York.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Pressed Steel Barrels.
Pressed Steel Tank Co., Milwaukee, Wis.

Presses and Dies.
Niagara Machine & Tool Works, Buffalo, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Pressure Regulators—Steam, Water and Air.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.

Propeller Wheels.
Marine Iron Works, Chicago, Ill.

Prospecting Drills.
American Diamond Rock Drill Co., 120 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Keystone Driller Co., Beaver Falls, Pa.
Star Drilling Machine Co., Akron, Ohio.

Production Engineers.
Gunn & Richards, 25 Pine St., New York.

Pulleys, Shafting and Hangers.
Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Denver Engineering Works, Denver, Colo.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Niles Tool Works Co., New York, N. Y.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
R. Poole & Son Co., Baltimore, Md.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Pulverizers.
F. W. Braun & Co., Los Angeles, Cal.

Pump Governors.
Power Specialty Co., 126 Liberty St., New York.

Pumps and Pumping Machinery.
Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
American Fire Engine Co., Seneca Falls, N. Y.
American Well Works, Aurora, Ill.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Geo. F. Blake Mfg. Co., 91 Liberty St., N. Y.
Bucyrus Co., So. Milwaukee, Wis.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Clayton Air Compress. Wks., 26 Cortlandt St., N.Y.
The Deane Steam Pump Co., of Holyoke, 115 Liberty St., New York.
Denver Engineering Works, Denver, Colo.
Epping-Carpenter Co., Pittsburg, Pa.
Flint & Walling Mfg. Co., Kendallville, Ind.
Guild & Garrison, Brooklyn, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
Chas. L. Heisler, Erie, Pa.
Henshaw, Bulkley & Co., San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.

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Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Knowles Steam Pump Wks., 91 Liberty St., N. Y
The Laidlaw-Dunn-Gordon Co., 120 Liberty St., N.Y.
Machinery & Electrical Co., Los Angeles, Cal.
John H. McGowan Co., Cincinnati, Ohio.
Morris Machine Works, Baldwinsville, N. Y.
Niagara Hydraulic Engine Co., Chester, Pa.
Pneumatic Eng'g Co., 128 Broadway, N. Y.
Providence Engineering Works, Providence, R. I.
Pulsometer Steam Pump Co., 135 Greenwich St., New York.
Wm. E. Quimby, 86 Liberty St., New York.
Rider-Ericsson Eng. Co., 35 Warren St., New York.
Snow Steam Pump Works, 114 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Union Steam Pump Co., Battle Creek, Mich.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 114 Liberty St., New York.

Pump Valves.

Boston Belting Co., Boston, Mass.
Power Specialty Co., 126 Liberty St., New York.

Punching and Shearing Machinery.

American Tool Works Co., Cincinnati, Ohio.
Bethlehem Foundry & Mch. Co., So. Bethlehem, Pa.
Buffalo Forge Co., Buffalo, N. Y.
Hilles & Jones Co., Wilmington, Del.
A. Garrison Foundry Co., Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Purge Apparatus.

Hancock Inspirator Co., 85 Liberty St., New York.

Pyrometers.

Charles Engelhard, 41 Cortlandt St., New York.

Quarrying Machinery.

A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
A. Leschen & Sons Rope Co., St. Louis, Mo.
John H. McGowan Co., Cincinnati, Ohio.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works Co., Toledo, Ohio.

Radiators.

A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.
Michigan Brass & Iron Works, Detroit, Mich.
John Simmons Co., 110 Centre St., New York.
H. B. Smith Co., 137 Centre St., New York.

Railway Shop Machinery.

Chester B. Albree, Allegheny, Pa.
Armstrong Mfg. Co., Bridgeport, Conn.
W. F. & John Barnes Co., Rockford, Ill
Bickford Drill & Tool Co., Cincinnati, Ohio.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Gould & Eberhardt, Newark, N. J.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works, Hamilton, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Pedrick & Ayer Co., Philadelphia, Pa.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson-Stillman Co., 210 E. 43d St., New York.

Railway Specialties.

Goodwin Car Co., 96 Fifth Ave., New York.
Arthur Koppel, 68 Broad St., New York.
Maryland Steel Co., Sparrows Point, Md.
Pennsylvania Steel Co., Steelton, Pa.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Pratt & Whitney Co., Hartford, Conn.
Sprague Electric Co., 527 W. 34th St., New York.
Star Brass Mfg. Co., Boston, Mass.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Air Brake Co., Pittsburg, Pa.

Refrigerating Machinery—SEE ICE-MAKING MACHINERY.

Rheostats.

Simplex Electric Heating Co., Cambridgeport, Mass.

Riveted Steel Pipe.

Herman Nieter, 39 Cortlandt St., New York.

Riveting Machines.

Chester B. Albree, Allegheny, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, Ohio.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Road-Making Machinery.

Aultman Co., Canton, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Rock Breakers.

Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Denver Engineering Works, Denver, Colo.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Sturtevant Mill Co., Boston, Mass.

Roofing.

Elaterite Roofing Co., San Francisco, Cal.
Passaic Rolling Mill Co., Paterson, N. J.
Warren Chemical & Mfg. Co., 81 Fulton St., N. Y.

Rolling Mill Machinery.

A. Garrison Foundry Co., Pittsburg, Pa.
Iroquois Machine Co., 150 Nassau St., New York.

Rolls, Chill and Sand.

A. Garrison Foundry Co., Pittsburg, Pa.

Rope Transmission.

American Mfg. Co., 63 Wall St., New York.
Aultman Company, Canton, Ohio.
Broderick & Bascom Rope Co., St. Louis, Mo.
H. W. Caldwell & Sons Co., Chicago, Ill.
Crocker-Wheeler Co., Ampere, N. J.
Dodge Mfg. Co., Mishawaka, Ind.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Providence Engineering Works, Providence, R. I.
S. Morgan Smith Co., York, Pa.

Rotary Pumps—Hand and Power.

American Fire Engine Co., Seneca Falls, N. Y.

Rubber Goods.

Boston Belting Co., Boston, Mass.
Jenkins Bros., 71 John St., New York.

Sand Mixers and Sifters.

Gould & Eberhardt, Newark, N. J.

Saw-Mill Machinery.

Allis-Chalmers Co., Chicago, Ill.
Chandler & Taylor Co., Indianapolis, Ind.
Denver Engineering Works, Denver, Colo.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.

Scales and Balances.

Wm. Ainsworth & Sons, Denver, Col.
F. W. Braun & Co., Los Angeles, Cal.

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Schools.

Brooklyn Polytechnic Institute, Brooklyn.
Chicago School of Assaying, Chicago, Ill.
Clarkson School of Technology, Potsdam, N. Y.
The Consolidated Schools, 156 Fifth Ave., N. Y.
Harvard University, Cambridge, Mass.
Lafayette College, Easton, Pa.
Lehigh University, So. Bethlehem, Pa.
Lewis Institute, Chicago, Ill.
Mass. Institute of Technology, Boston, Mass.
McGill University, Montreal.
Michigan College of Mines, Houghton, Mich.
Michigan Military Academy, Orchard Lake, Mich.
New York Military Academy, Cornwall, N. Y.
Norwich University, Northfield, Vt.
Pennsylvania Military College, Chester, Pa.
Pratt Institute, Brooklyn, N. Y.
Rensselaer Polytechnic Institute, Troy, N. Y.
Rose Polytechnic Institute, Terre Haute, Ind.
Sheffield Scientific School of Yale University, New Haven, Conn.
So. Dakota School of Mines, Rapid City, S. D.
State College of Kentucky, Lexington, Ky.
Stevens Institute of Technology, Hoboken, N. J.
Thayer School of Civil Engineering, Hanover, N. H.
Tufts College, Tufts College, Mass.
University of Kansas, Lawrence, Kan.
University of Pennsylvania, Philadelphia, Pa.
University of Tennessee, Knoxville, Tenn.
University of Wisconsin, Madison, Wis.

Screens, Mining.

Robert Aitchison Perforated Metal Co., Chicago, Ill.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Denver Engineering Works, Denver, Colo.
Eastwood Wire Mfg. Co., Belleville, N. J.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Monongahela Mfg. Co., Monongahela, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Screw Machines.

American Tool Works Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pearson Machine Co., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.

Search Lights and Projectors.

Chas. J. Bogue, 217 Centre St., New York.

Separators, Steam and Oil.

Allis-Chalmers Co., Chicago, Ill.
Austin Separator Co., Detroit, Mich.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Goubert Mfg. Co., 85 Liberty St., New York.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harrison Safety Boiler Works, Philadelphia, Pa.
Watson & McDaniel Co., Philadelphia, Pa.

Shafting—SEE PULLEYS.

Shapers.

American Tool Works Co., Cincinnati, Ohio.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Niles Tool Works Co., Hamilton, Ohio.
Potter & Johnston, Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Shears—SEE PUNCHING MACHINERY.

Skylights (Steel Puttyless).

National Skylight & Construction Co., 120 Liberty St., New York.
Valle & Young, Baltimore, Md.

Smelters and Refiners.

Copper King Ltd., San Francisco, Cal.

Smelting Machinery.

Denver Engineering Works, Denver, Colo.

Special Machinery.

H. G. Barr, Worcester, Mass.

Stand Pipes.

Herman Nieter, 39 Cortlandt St., New York.

Steam Engine Indicator.

Star Brass Mfg. Co., Boston, Mass.

Steam Meters.

G. C. St. John, 143 Liberty St., New York.

Steam-Regulating Appliances.

Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
Julian D'Este Co., 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jenkins Brothers, 71 John St., New York.
The Lunkenheimer Co., Cincinnati, Ohio.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., W. Pittsburg, Pa.

Steam Pile Hammers.

A. F. Bartlett & Co., Saginaw, Mich.

Steam Shovels.

The Bucyrus Co., So. Milwaukee, Wis.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.

Steam Specialties.

Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
The Lunkenheimer Co., Cincinnati, O.
Michigan Brass & Iron Works, Detroit, Mich.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
John Simmons Co., 110 Centre St., New York.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wm. H. Wilkinson & Co., 352 Atlantic Ave., Boston, Mass.

Steam Superheaters.

Power Specialty Co., 126 Liberty St., New York.
Providence Engineering Works, Providence, R. I.

Steam Traps.

American Blower Co., Detroit, Mich.
Eureka Iron Co., 59-61 So. Canal St., Chicago, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Julian D'Este Company, 24 Canal St., Boston, Mass.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.
John Simmons Co., 110 Centre St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

Steam Yachts.

Gas Engine & Power Co., Morris Heights, N. Y.
Marine Iron Works, Chicago, Ill.
Charles L. Seabury & Co., Morris Heights, N. Y.

Steel.

Bethlehem Steel Co., So. Bethlehem, Pa.
Wm. Jessop & Sons, Ltd., 91 John St., New York.
Latrobe Steel Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Passaic Rolling Mill Co., Paterson, N. J.
Pennsylvania Steel Co., Steelton, Pa.
Walworth Manufacturing Co., Boston, Mass.

Steel Flanges.

Latrobe Steel Co., Philadelphia, Pa.

Steel Tanks.

Pressed Steel Tank Co., Milwaukee, Wis.

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Stokers—Mechanical.

American Stoker Co., 277 Broadway, New York.
Babcock & Wilcox Co., 85 Liberty St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Stoppers.

R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Storage Batteries.

Electric Storage Battery Co., Philadelphia, Pa.

Structural Iron Work.

Chester B. Albree, Allegheny, Pa.
Browning Engineering Co., Cleveland, Ohio.
Columbia Bridge Co., Pittsburg, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Sugar-House Machinery.

American Tool & Machine Co., Boston, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Tanks, Iron.

Allis-Chalmers Co., Chicago, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
Denver Engineering Works, Denver, Colo.
L. O. Koven & Brother, 50 Cliff St., New York.
Herman Nieter, 39 Cortlandt St., New York.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.

Tanks, Wood.

W. E. Caldwell Co., Louisville, Ky.
Ralph B. Carter, 26 Cortlandt St., New York.

Tapping and Reaming Machines.

Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.

Telephones.

Ericsson Telephone Co., 296 Broadway, New York

Tenoning Machines.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Thermometers.

Bristol Co., Waterbury, Conn.
Charles Engelhard, 41 Cortlandt St., New York.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.
Queen & Co., Inc., Philadelphia, Pa.

Tires—Steel.

Latrobe Steel Co., Philadelphia, Pa.

Tool Holders.

Fay & Scott, Dexter, Me.

Tool Racks.

New Britain Machine Co., New Britain, Conn.

Traveling Cranes.

Denver Engineering Works, Denver, Colo.
Pawling & Harnischfeger, Milwaukee, Wis.
Shaw Electric Crane Co., Muskegon, Mich.

Traveling Derricks.

Hayden & Derby Mfg. Co., New York.
Hayward Co., 97 Cedar St., New York.

Turbine Water-Wheels.

Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Pelton Water Wheel Co., San Francisco, Cal.
R. Poole & Son Co, Baltimore, Md.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio
R. D. Wood & Co., Philadelphia, Pa.

Turnbuckles.

John Simmons Co., 110 Centre St., New York.

Turn Tables.

Dodge Mfg. Co., Mishawaka, Ind.
Arthur Koppel, 68 Broad St., New York.
Passaic Rolling Mills Co., Paterson, N. J.
Wm. Sellers & Co., Philadelphia, Pa.

Turret Lathes.

Niles Tool Works Co., Hamilton, Ohio.
Pearson Machine Co., Chicago, Ill.
Potter & Johnston, Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.

Typewriters.

Wyckoff, Seamans & Benedict, New York.

Vacuum and Draft Gauges.

Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Vacuum Pumps.

Alberger Condenser Co., 95 Liberty St., New York.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Clayton Air-Compress. Wks., 26 Cortlandt St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.
Guild & Garrison, Brooklyn, N. Y.
John H. McGowan Co., Cleveland, Ohio.
Pearson Machine Co., Chicago, Ill.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Union Steam Pump Co., Battle Creek, Mich.

Valves—Gas, Steam, and Water.

Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
Foster Engineering Co., Newark, N. J.
Hancock Inspirator Co., 85 Liberty St., New York.
Jenkins Bros., 71 John St., New York.
Kelly & Jones Co., Greensburg, Pa.
Kennedy Valve Mfg. Co., 70 Beekman St., N. Y.
The Lunkenheimer Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Michigan Brass & Iron Works, Detroit, Mich.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Power Specialty Co., 126 Liberty St., New York.
Wm. Powell Co., Cincinnati, Ohio.
Ross Valve Co., Troy, N. Y.
John Simmons Co., 110 Centre St., New York.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wellman-Seaver-Morgan Eng'ng Co., Cleveland, O.

Ventilating Appliances—SEE HEATING AND VENTILATING.

Wage Calculators.

Calculagraph Co., 9-13 Maiden Lane, New York.
Carlton Mfg. Co., 76 Franklin St., New York.

Watchman's Time Detectors.

American Watchmen's Time Detector Co., 234 & 235 Broadway, New York.

Water-Closets.

John Simmons Co., 110 Centre St., New York.

Water Heaters.

Hayden & Derby Mfg. Co., New York.

Water Lifts.

American Well Works, Aurora, Ill.
Clayton Air Compress. Wks., 26 Cortlandt St., N.Y.
Hall Steam Pump Co., Pittsburg, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Pneumatic Engineering Co., 128 B'way, N. Y.

Water Meters.

Builders' Iron Foundry, Providence, R. I.
John Simmons Co., 110 Centre St., New York.
Standard Water Meter Co., 245 Robinson St., Brooklyn, N. Y.

Water Power Installation.

Dayton Globe Iron Works Co., Dayton, O.

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New York Continental Jewell Filtration Co., 15 Broad St., New York.
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Babcock & Wilcox Co., 85 Liberty St., New York.
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Denver Engineering Works, Denver, Colo.
Gas Engine & Power Co., Morris Heights, N. Y.
Heine Safety Boiler Co., St. Louis, Mo.
Henshaw, Bulkley & Co., San Francisco, Cal.
Marine Iron Works, Chicago, Ill.
Charles L. Seabury & Co., Morris Heights, N. Y.
The Stirling Co., Chicago, Ill.
Taylor Water Tube Boiler Co., Detroit, Mich.

Water-Works Pumping Machinery.

Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Keystone Driller Co., Beaver Falls, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Mine & Smelter Supply Co., Denver, Col.
Snow Steam Pump Works, Buffalo, N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Union Steam Pump Co., Battle Creek, Mich.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 114 Liberty St., New York.

Water-Works Supplies.

American Well Works, Aurora, Ill.
W. E. Caldwell Co., Louisville, Ky.
John Simmons Co., 110 Centre St., New York.
Star Drilling Machine Co., Akron, Ohio.
U. S. Cast Iron Pipe & Foundry Co., Phila., Pa.
R. D. Wood & Co., Philadelphia, Pa.

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American Diamond Rock Drill Co., 120 Liberty St., New York.
American Well Works, Aurora, Ill.
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Star Drilling Machine Co., Akron, Ohio.
St. Louis Well Machine & Tool Co., St. Louis, Mo.
Williams Bros., Ithaca, N. Y.

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W. E. Caldwell Co., Louisville, Ky.
Flint & Walling Mfg. Co., Kendallville, Ind.

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Iroquois Machine Co., 150 Nassau St., New York.
Morgan Construction Co., Worcester, Mass.

Wood Making Machinery.

American Machinery Co., Grand Rapids, Mich.

Wire, Insulated—SEE INSULATED WIRE.

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A. Leschen & Sons Rope Co., St. Louis, Mo.
Phosphor Bronze Smelt. Co., Ltd., Philadelphia, Pa.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

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J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
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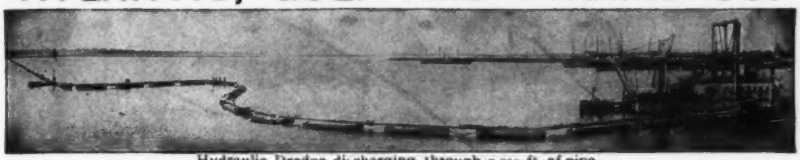

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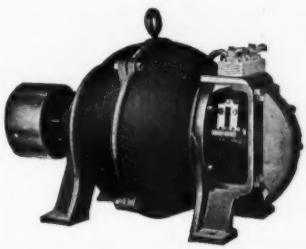

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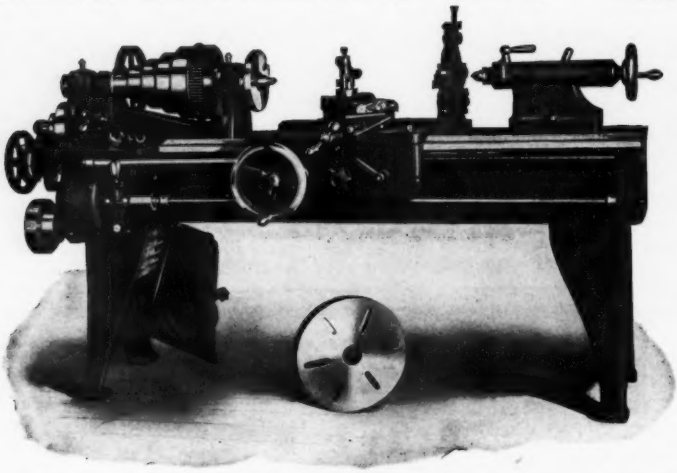

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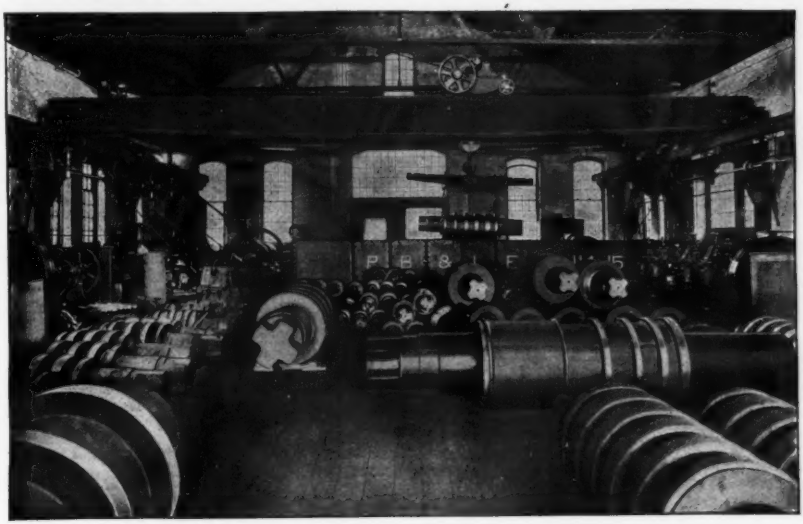

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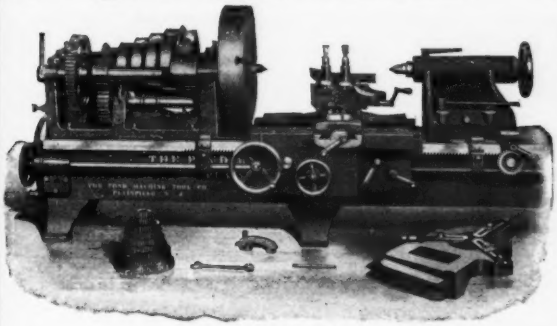

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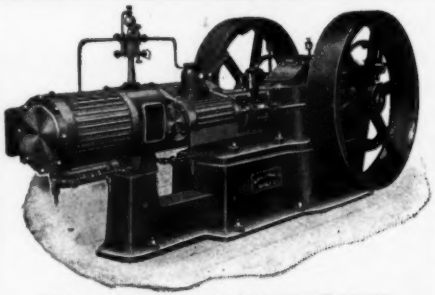

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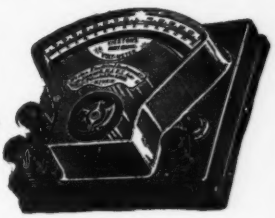

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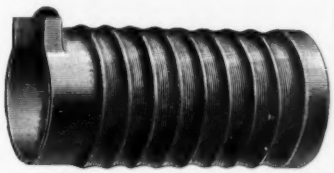

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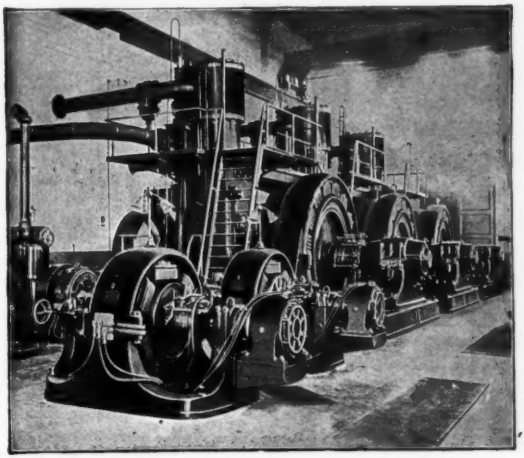

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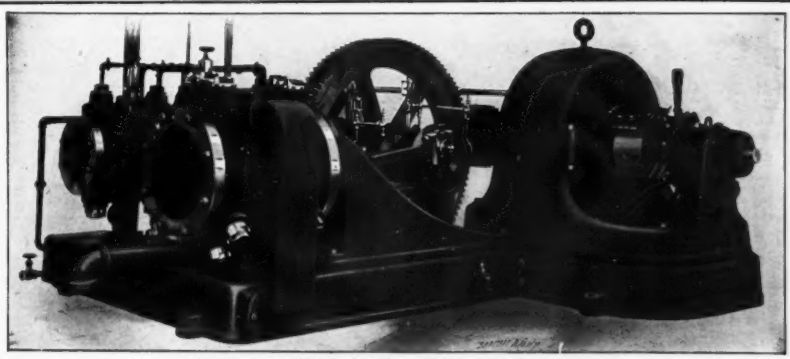

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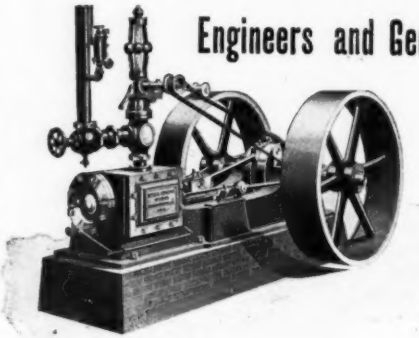

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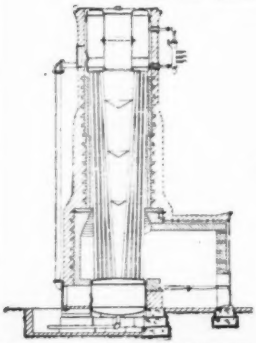

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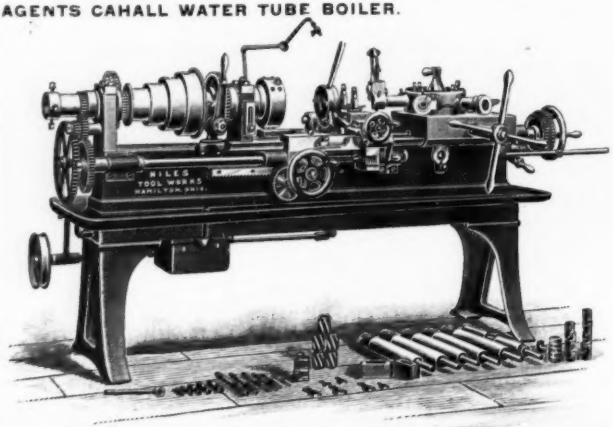

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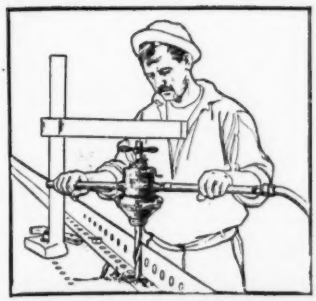

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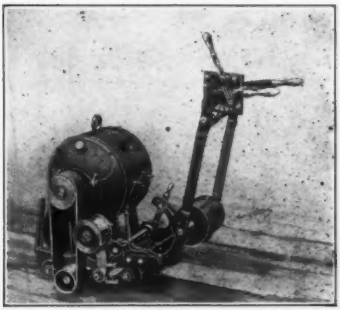

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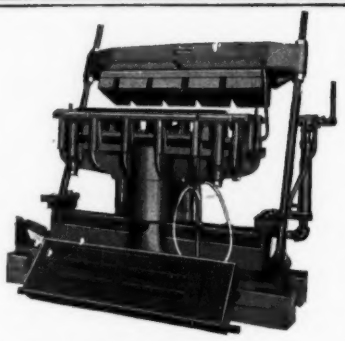

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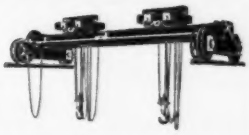
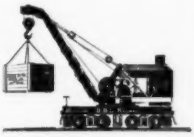

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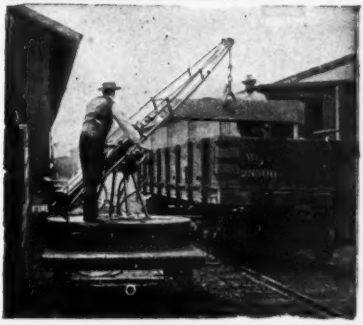

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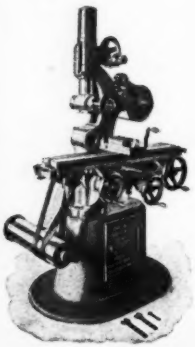

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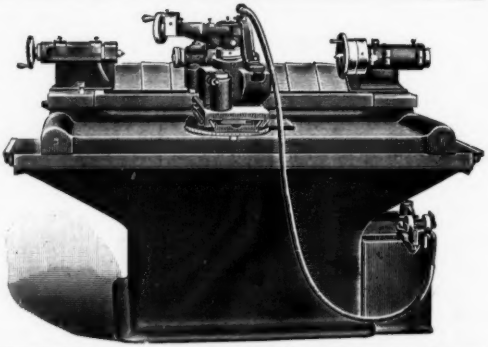

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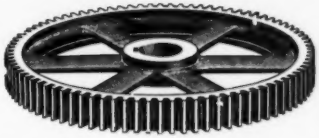

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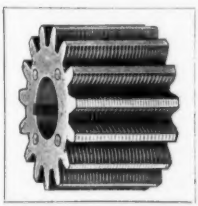

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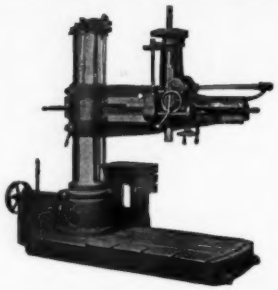

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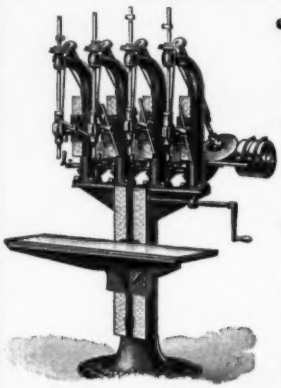

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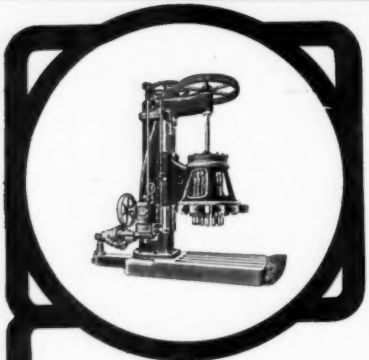

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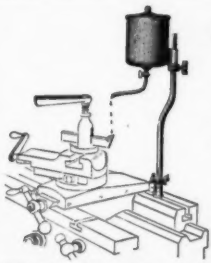

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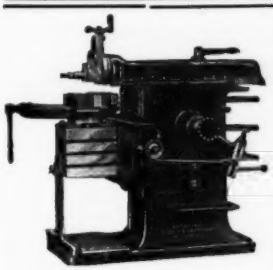

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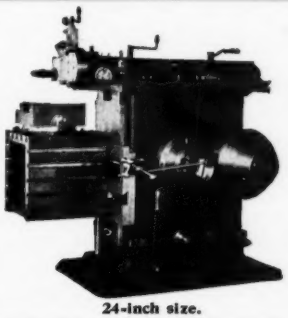

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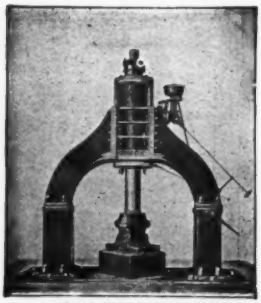

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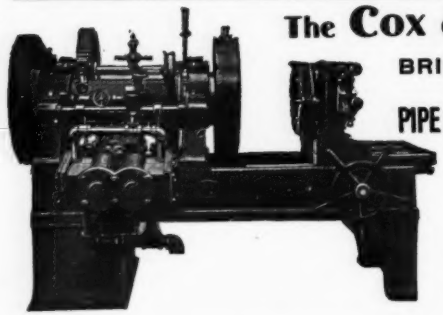

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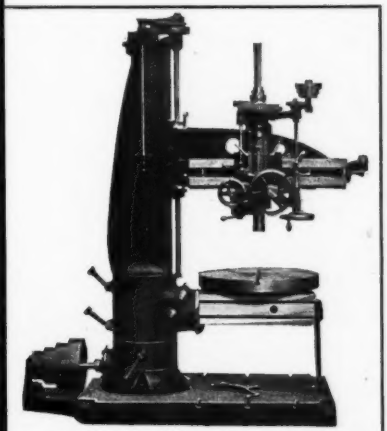

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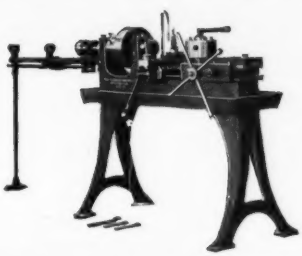

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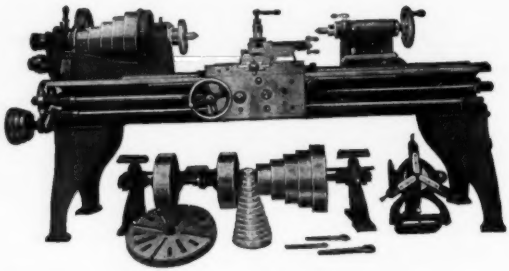

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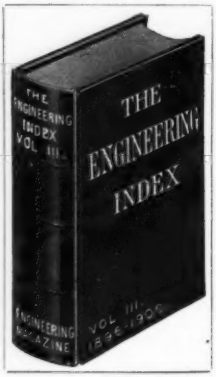

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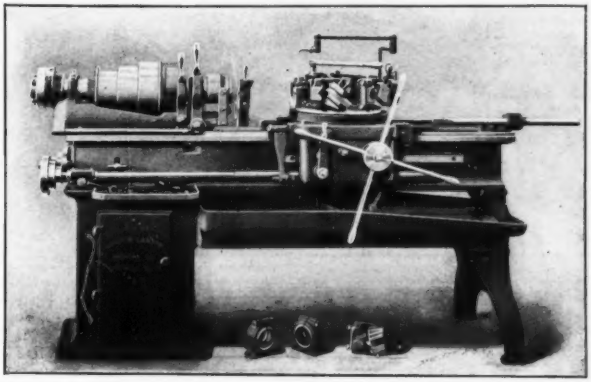

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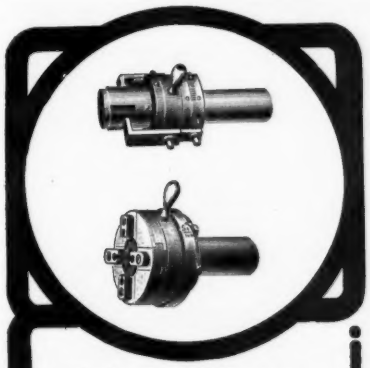

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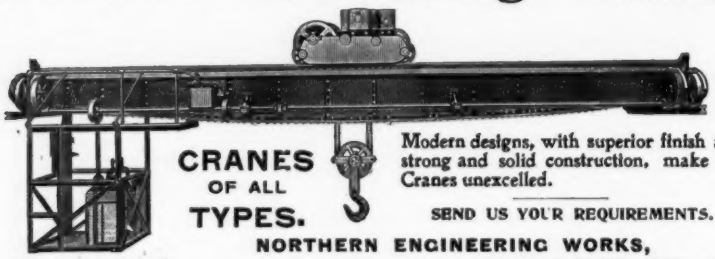

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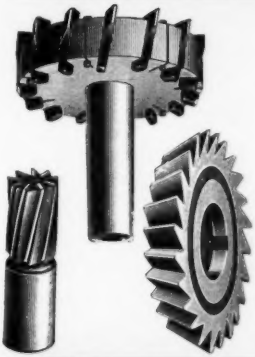

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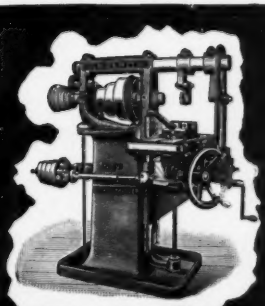

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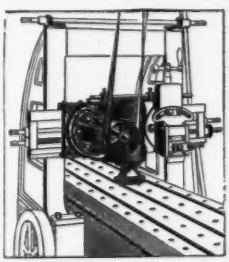

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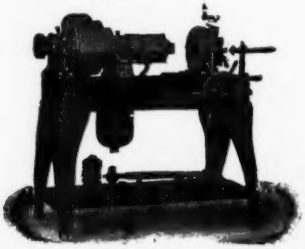

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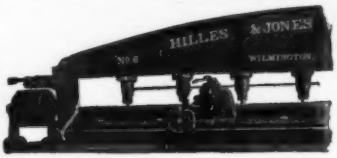

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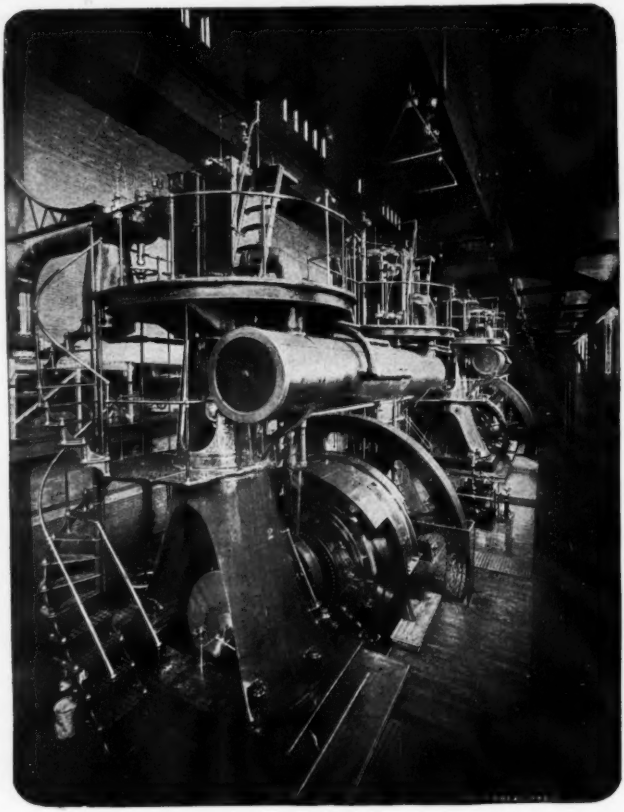

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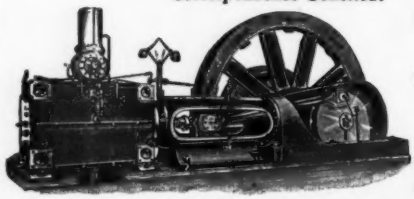

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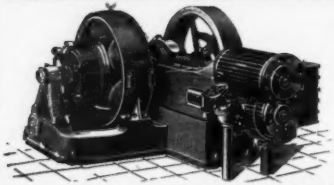

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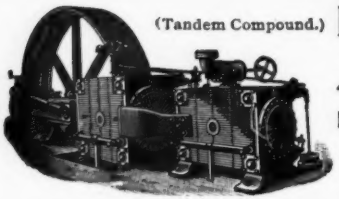

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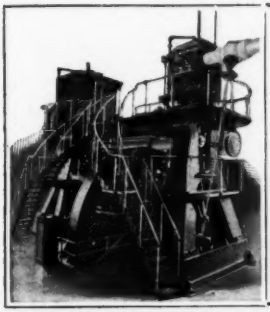

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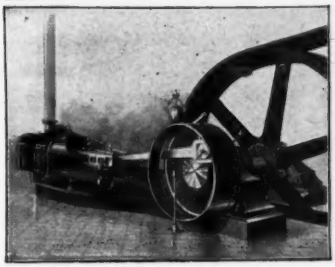

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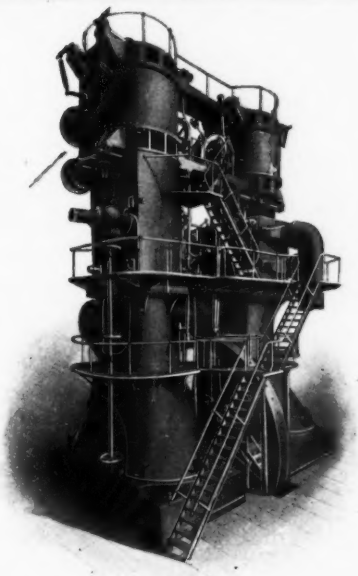

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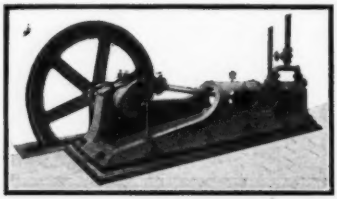

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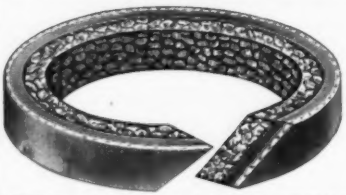

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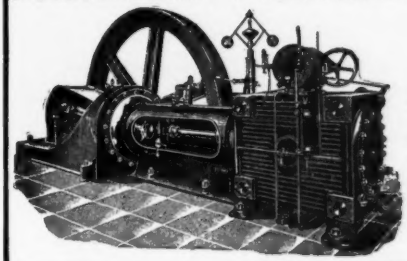

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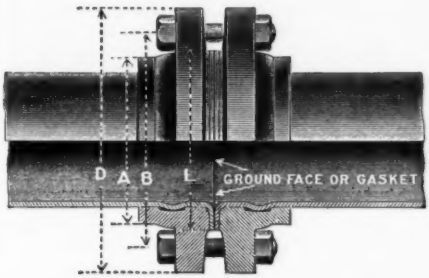

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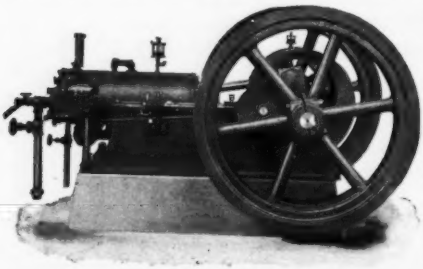

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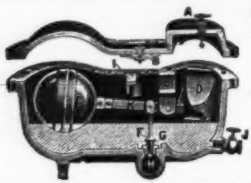

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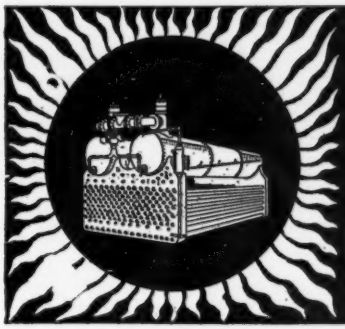

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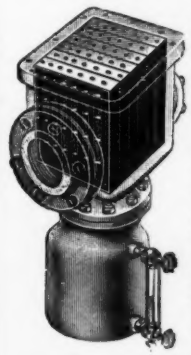

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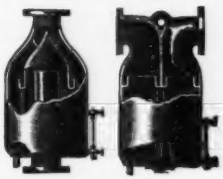

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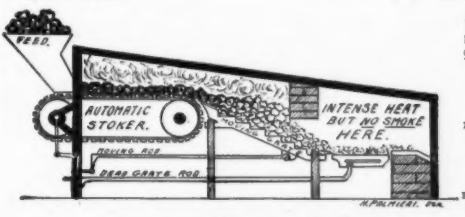

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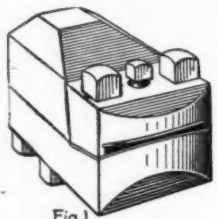

Fig. 1.
Perspective View.

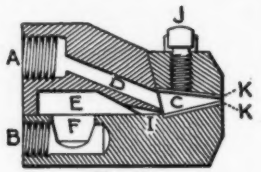

Fig. 2.
Longitudinal Section.

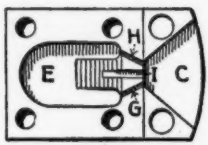

Fig. 4.
Plan, with Bottom Removed.

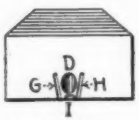

Fig. 3. Elevation, Bottom and Front Removed.

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D. Oil Inlet Duct.
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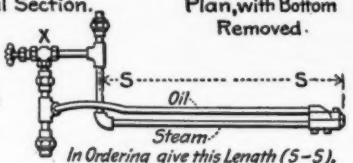

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Fig. 5.
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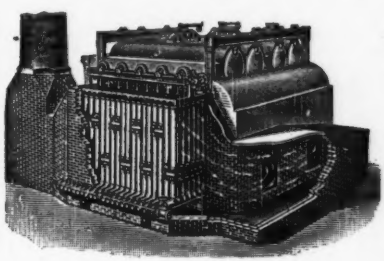

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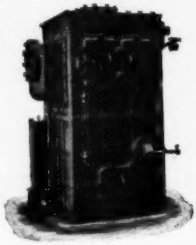

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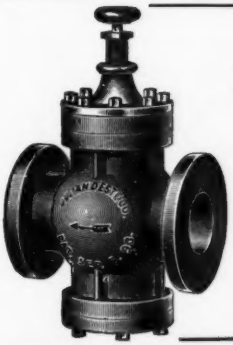

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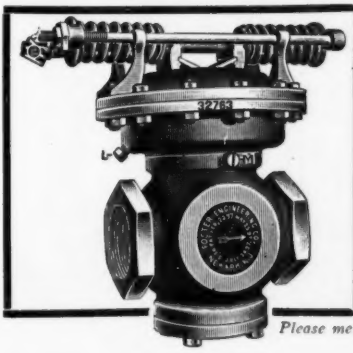

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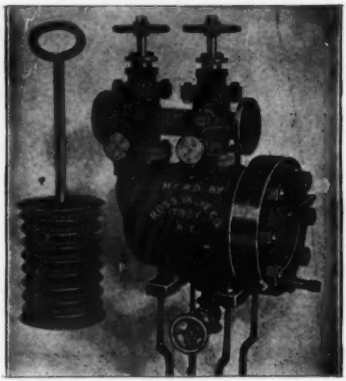

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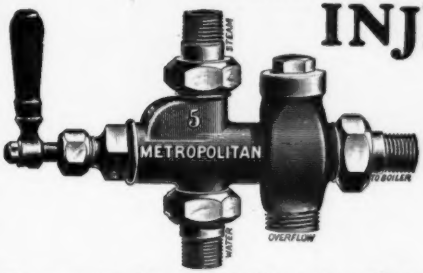

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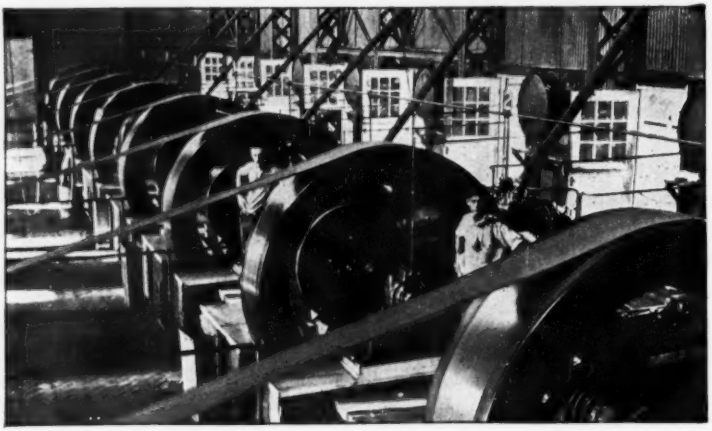

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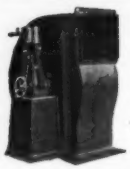

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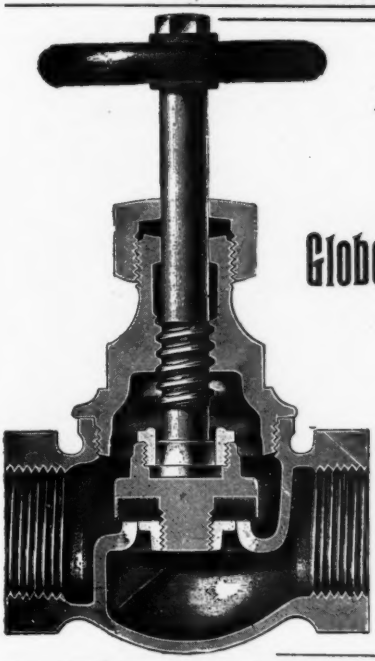

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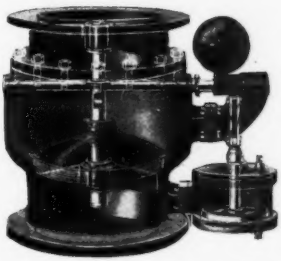

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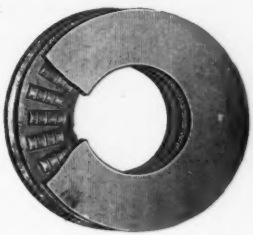

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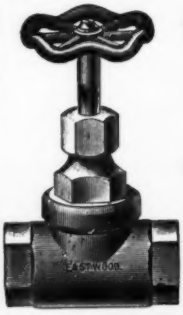

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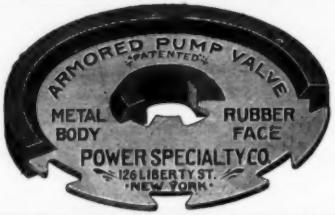

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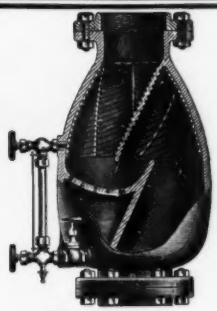

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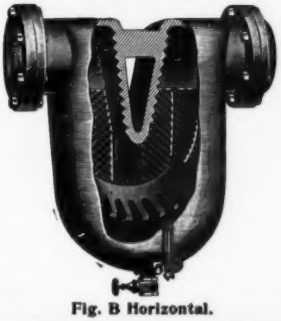

Fig. B Horizontal.

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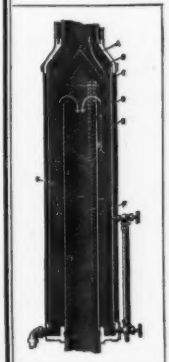

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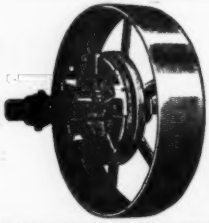

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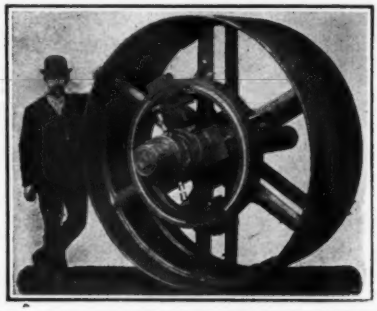

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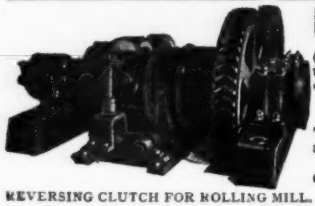

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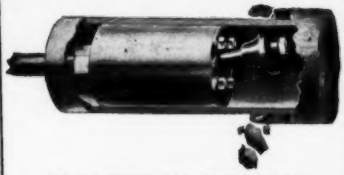

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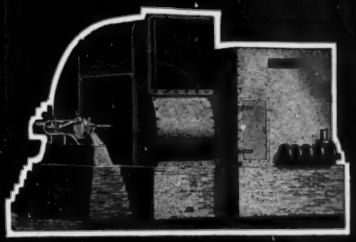

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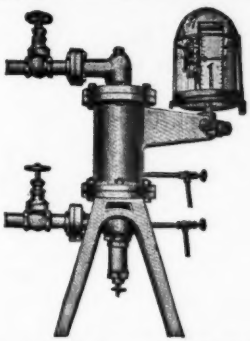

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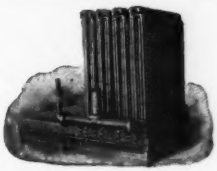

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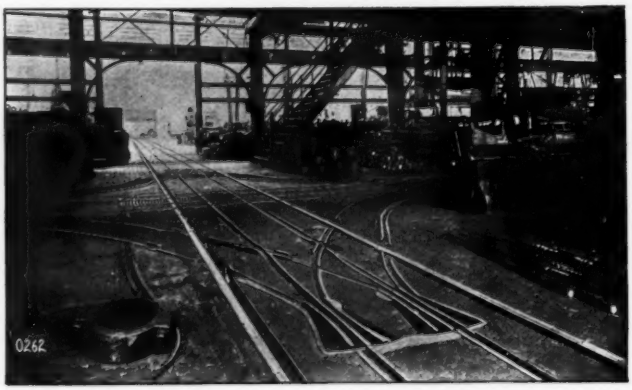

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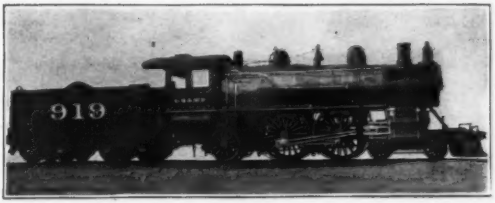

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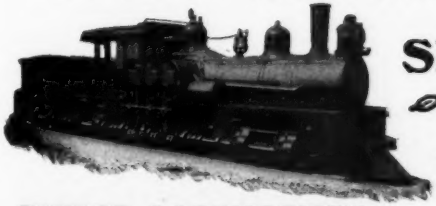

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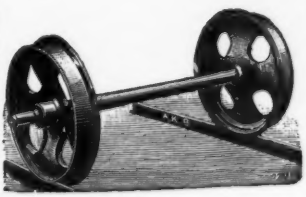

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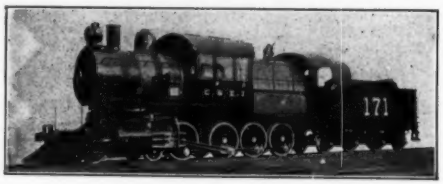

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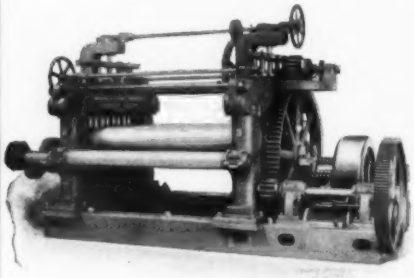

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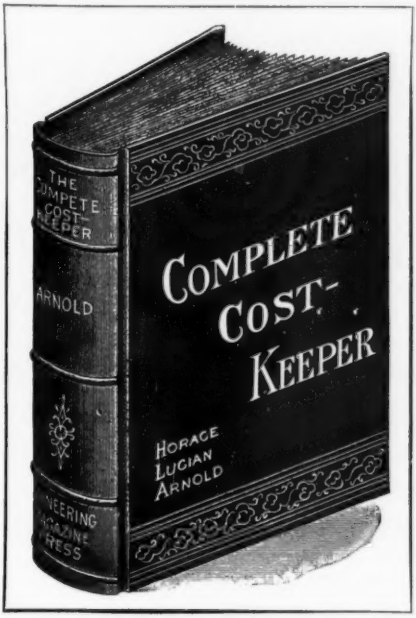

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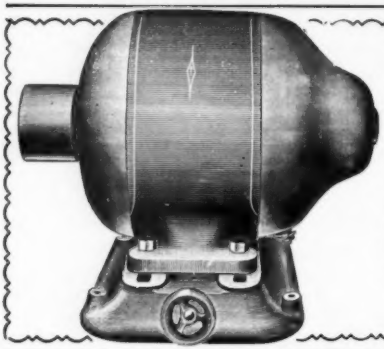

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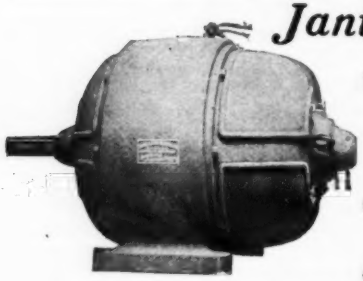

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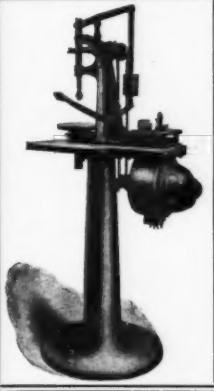

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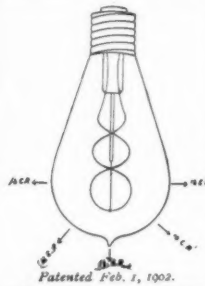

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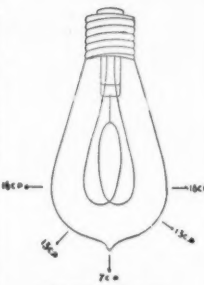

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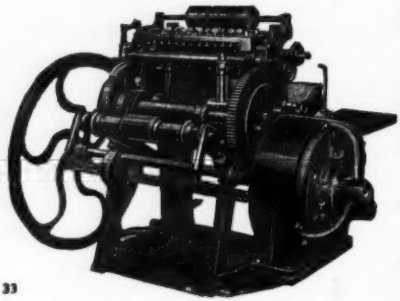

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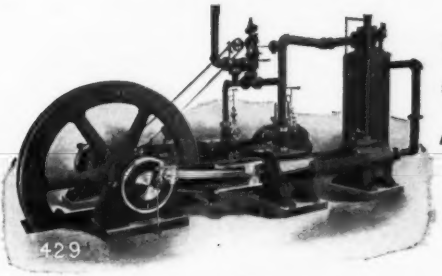

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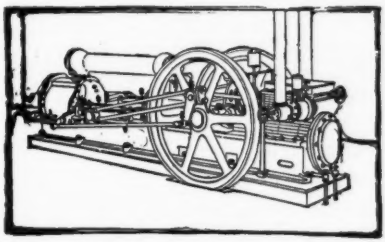

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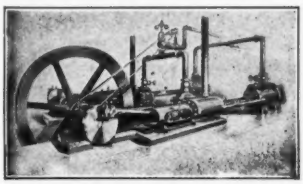

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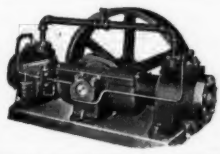

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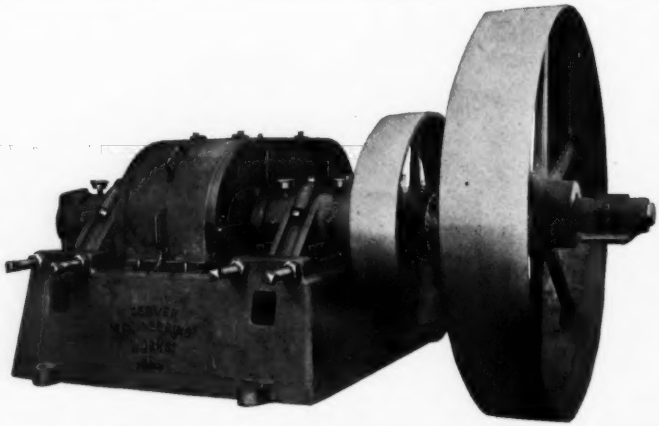

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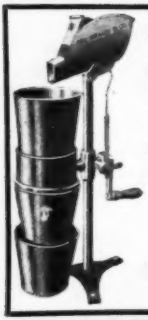

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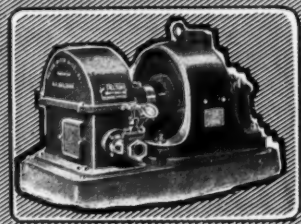

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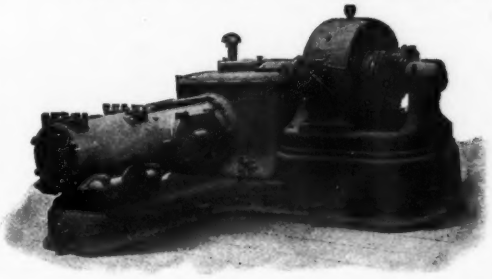

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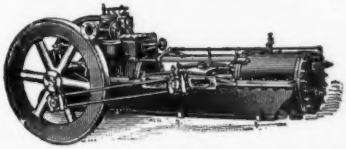

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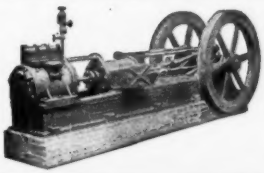

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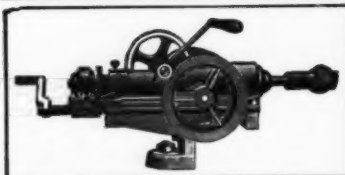

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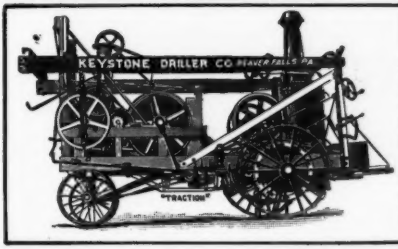

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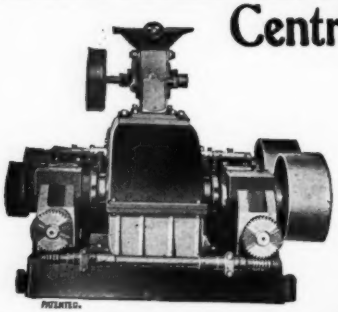

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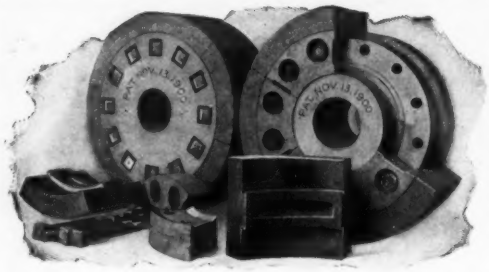

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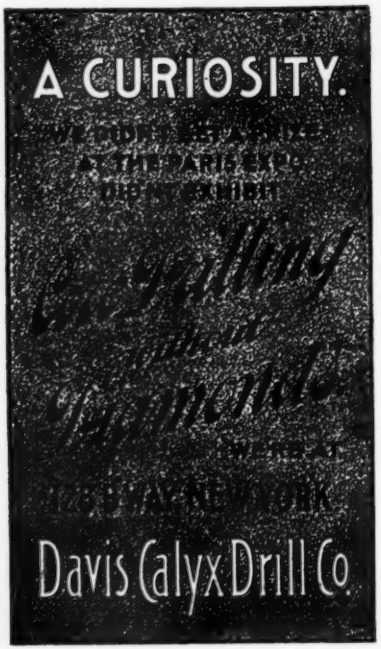

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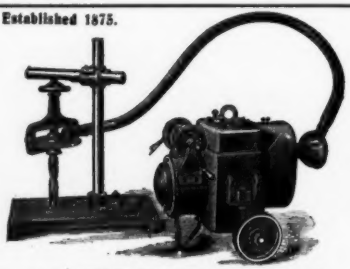

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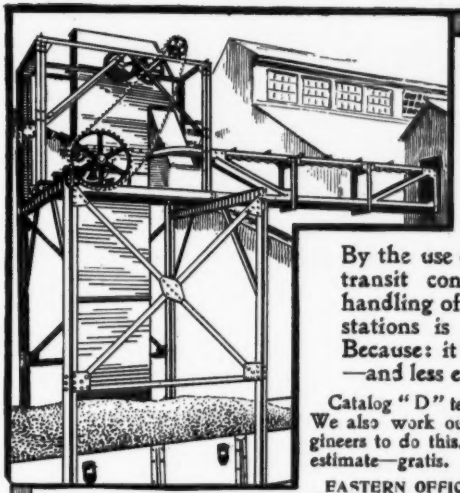

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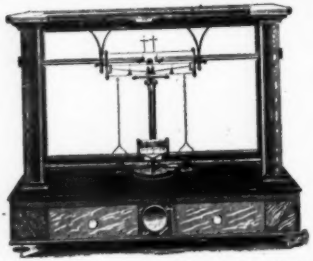

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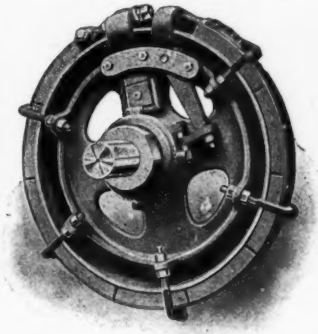

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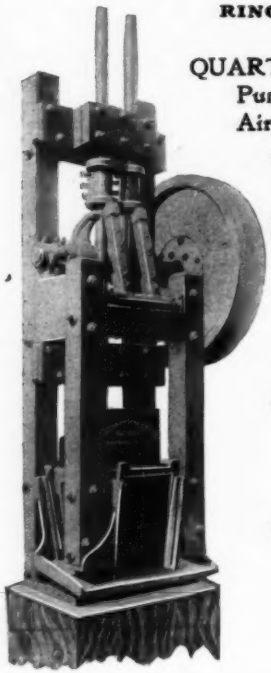

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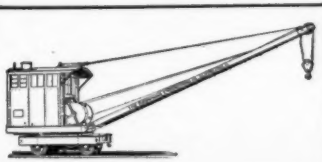

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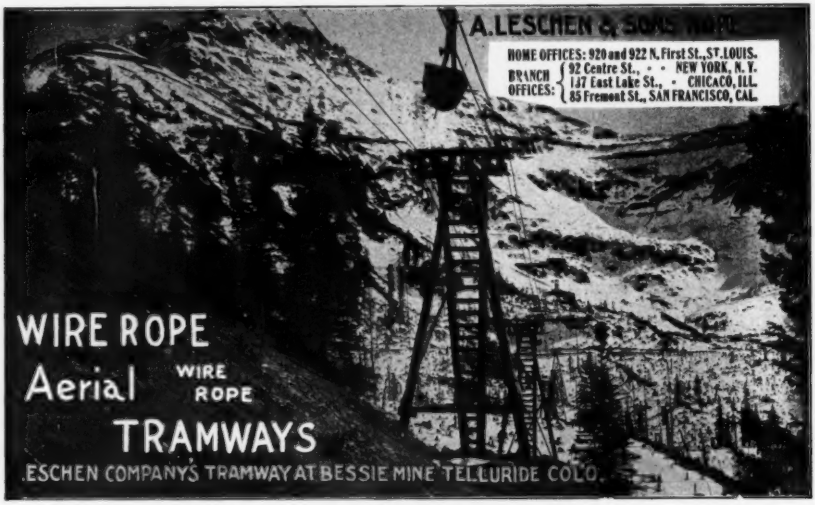
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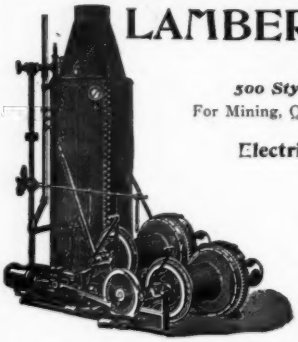

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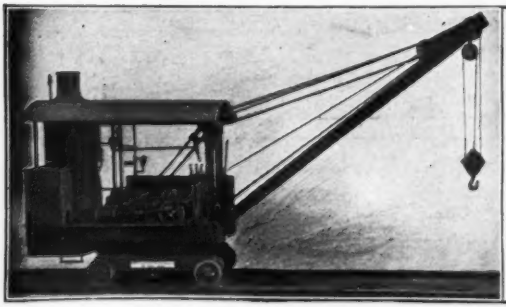

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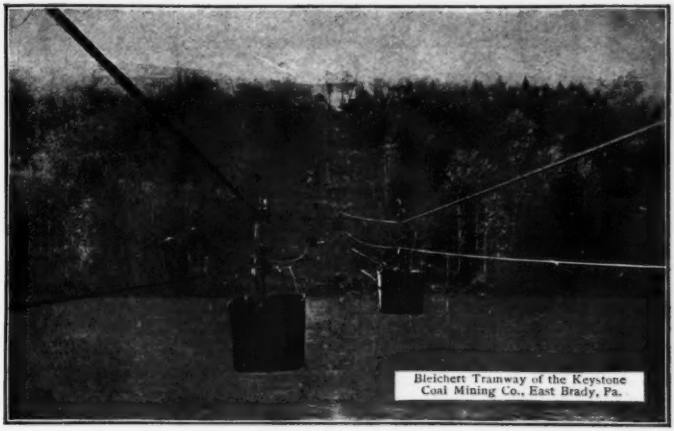

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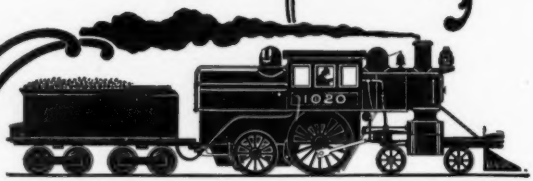

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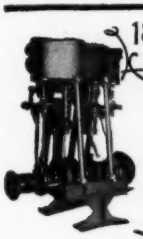

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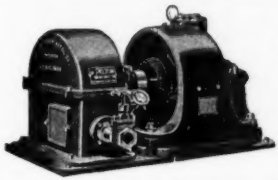

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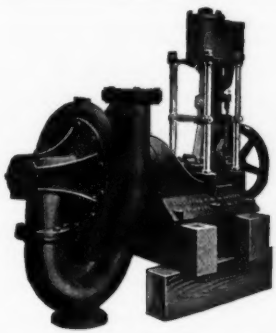

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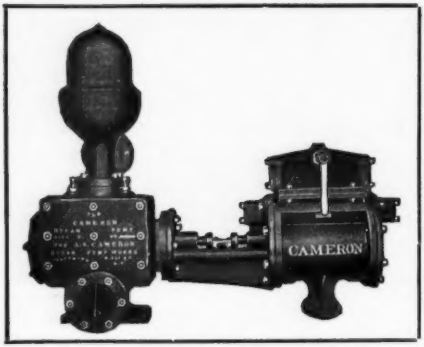

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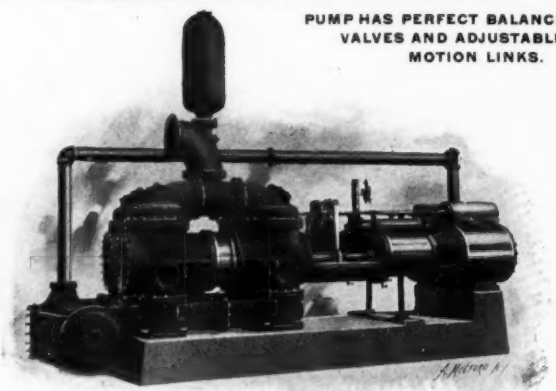

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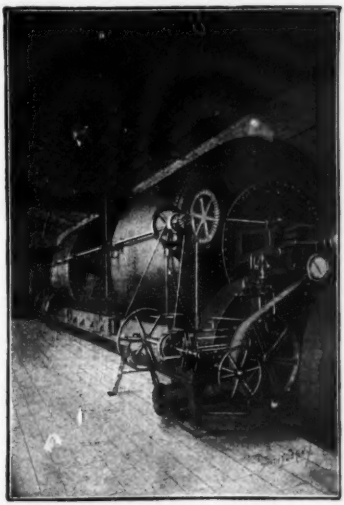

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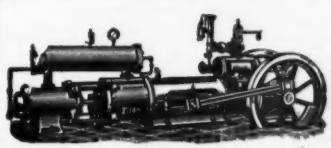

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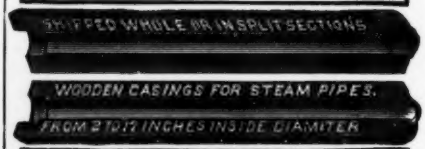

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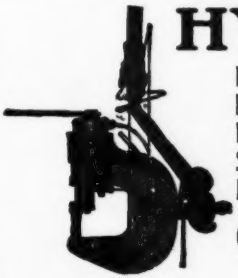

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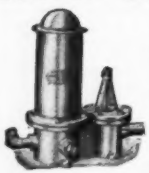

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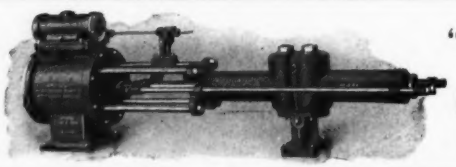

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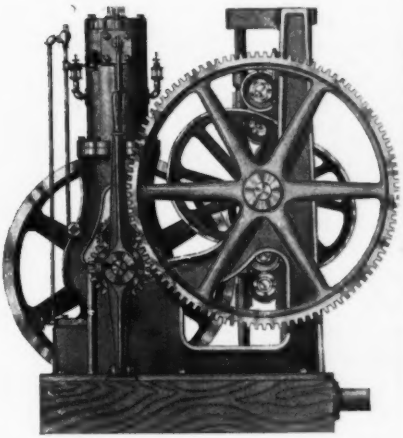

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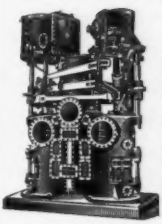

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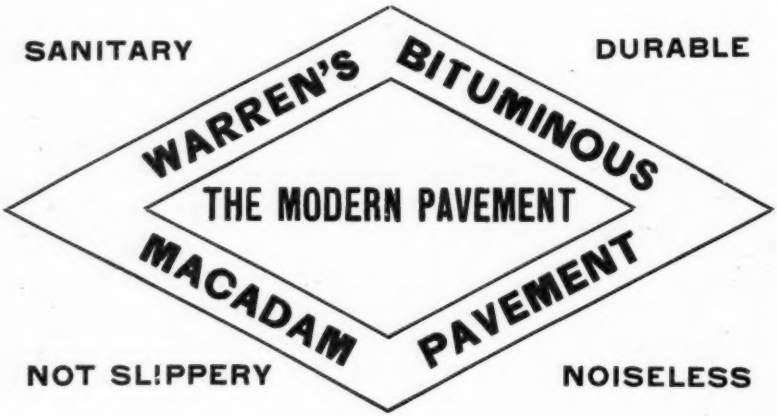

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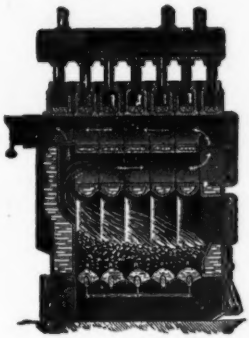

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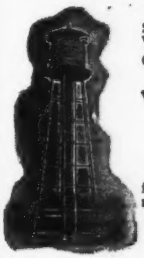

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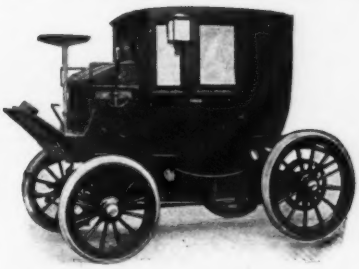

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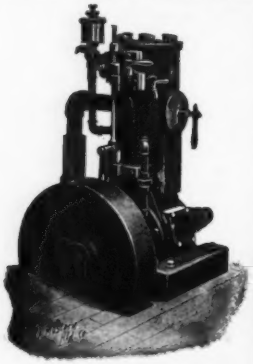

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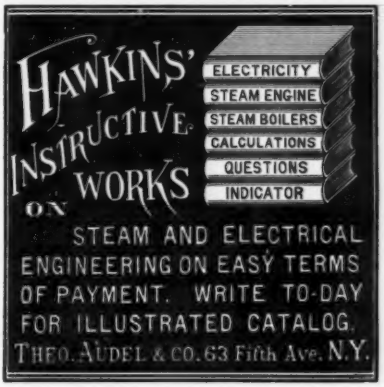

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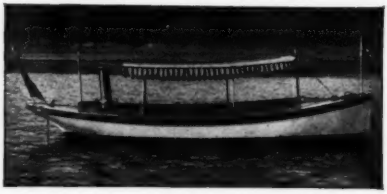

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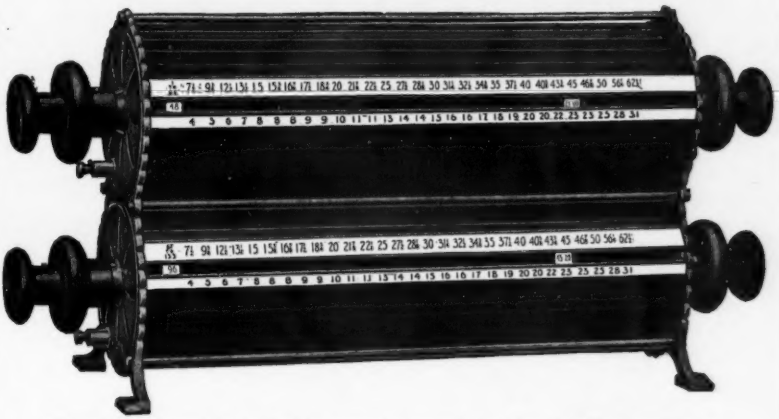

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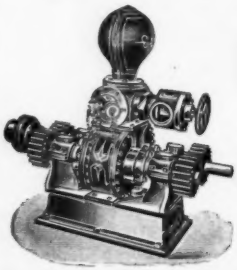

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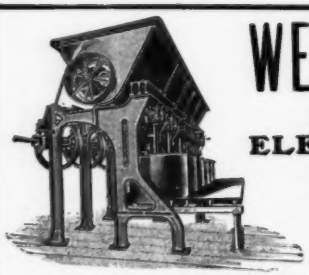

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